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Journal of the Society of Arts.

FRIDAY FEBRUARY 14, 1862.

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MEMORIAL TO HIS LATE ROYAL HIGHNESS THE PRINCE CONSORT.

A special general meeting of this Society was held on Friday last, duly convened in accordance with Bye Law 50, for the purpose of receiving a report from the Council in reference to their vote of 1,000 guineas to the fund now being raised for a memorial to the Prince Consort The chair was taken by Mr. J. Griffith Frith.

The Secretary read the Bye Law under which the meeting was convened, and the advertisement convening the meeting.

The Secretary then read the following report from the Council:—

The Council have thought it right to vote a sum of 1,000 guineas towards the erection of the Memorial to their late lamented President, his Royal Highness the Prince Consort. In order to give the fullest effect to that vote, the Council have called a General Meeting of the Society, that all its members may participate in the act.

The Council is confident that the Society at large will eagerly confirm the appropriation of this money to the object of commemorating the rare virtues of a Prince to whom this Society, above all others, owes so much—not only for the great impulse given by his Royal Highness to the progress of Arts, Manufactures, and Commerce, but for the increased social status which his enlightened influence has contributed to confer on the leaders of industry.

If facts were requisite to impress Members with the sense of gratitude for the remarkable services of the Prince to this Society, they would be found in the following statement:—In 1843, the year of his Royal Highness' election as President, the number of subscribing members was 319; their payments, £724; and the deficit on the year £298. At the time of his death the number of members was 2,454, the Society had formed a Union of 300 Institutions, extending its influence over the United Kingdom and the Colonies. Its income had increased to nearly £5,520. It had paid off large incumbrances, and it has upwards of £13,000 funded property.

The Chairman moved that the report be received and adopted.

The motion having been seconded by Mr. J. Scott Russell, F.R.S., was carried unanimously.

INTERNATIONAL EXHIBITION OF 1862.

The Council beg to announce that the Guarantee Deed is now lying at the Society's House for signature, and they will be much obliged if those gentlemen who have given in their names as Guarantors, as well as others interested in the Exhibition, will make it convenient to call there and attach their signatures to the Document. Signatures for sums amounting in the aggregate to £446,000, have been attached to the Deed.

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Guarantors holding ivory tickets for visiting the building are informed that those tickets are no longer available.

WEEKLY PROGRESS OF THE INTERNATIONAL EXHIBITION.

On Sunday last, three enormous ensigns waved over the top of the Eastern dome, proclaiming to the public the practical completion of the work. The glazing only remains to finish it, inasmuch as the whole of the ironwork is completed, and the centreing supporting the ribs struck. The finial, with its gilded globe and spear, was hoisted and fixed on the 6th inst. Rising, as it does, 53 feet above the apex of the dome, it presents a striking and graceful finish to this stupendous and interesting feature of the work.

It will give consolation, perhaps, to those who have expressed publicly their doubt as to the strength of this structure to hear, that on the centreing supporting the ribs being removed, the face of the apex showed a deflection of one-eighth of an inch, an inappreciable amount when the immense size of the girders and also the play left for the expansion of the iron are considered. The western dome is fast following at the heels of her sister, and by the end of the coming week there will be little of the work left for completion. On Thursday morning the gilded finial was erected on this dome.

The Picture Gallery is ready for Mr. Crace to decorate. His particolouring of the nave and transept roofs is criticised as disregarding the construction of the roof, giving it the appearance of great instability, but as a whole his colouring is successful.

Some idea of the rapidity with which the contractors are now finishing off the work may be formed by the progress made in the brick casing for the steam pipes in the western annexe, which was completed on Wednesday, having only been commenced on the Wednesday previous. In this casing there are 4,100 feet of 9-inch brickwork four feet high.

The Commissioners, impressed with the necessity of convincing the public that they might feel perfectly secure in every part of the building, proceeded on Wednesday to test the gallery floors by a dense crowd of men. This to a scientific mind cannot be considered other than a work of supererogation, yet, for the satisfaction of the public, who do not appreciate the value and accuracy of certain formulæ for calculating the strength of materials, such a step was necessary.

Before the scantlings of the various materials which form the floors were decided upon, every part was actually tested by a dead weight, equal to that of the densest crowd that could by any possibility be collected. The cast-iron girders were made capable of carrying three times the load that could be put on them, and a specimen of the flooring employed was loaded with bricks to 140 lbs. to the superficial foot. It could not have been, therefore, with any misgiving that the contractors marshalled their men for proving the floors on the 10th inst., but it must have been with a feeling of pride and defiance that they awaited the result of the experiment, the object of which was to enable the Commissioners to say "The floors are perfectly safe; we have had a dense crowd of men walking and running over them, and they have not yielded a fraction."

At 3 p.m., the Commissioners assembled in the building, and some of the Building Committee were also present. A body of 400 workmen were arranged so as to present a front equal to the width of a gallery, and headed by Mr. W. Fairbairn, acting as leader, and Messrs. Clemence and Ashton, clerks of works, as adjutants, and the master blacksmith as sergeant-major, they dashed up the stairs, at the head of which they formed into as dense a mass as possible, and then walked and ran all over the galleries. The result of the test was most satisfactory. The floors, of course, vibrated with the heavy moving load, yet they always recovered themselves on the men being withdrawn. As the living mass moved on, the deflections of various portions of the floor were observed; these were found to average as follows:

For 25 feet, cast-iron girders. . .	¼ inch.
„ 25 feet, suspended trusses . .	⅝ „
„ 8½ feet, floor joists.	1 „

The Commissioners formally took possession of the building on Wednesday last, and the French Commission had their space delivered to them at the same time. A model has been made of the arrangements to be adopted, and the French goods will commence their arrival forthwith. Some Russian and Colonial objects are already in the docks.

The responsible work of receiving and placing the goods in their proper places in the building, has been confided to Mr. R. Thompson, who performed a similar duty in Dublin and Paris.

Mr. Philip C. Owen has been offered the post of Foreign Superintendent.

The Commissioners have appointed Dr. Lyon Playfair, C.B., as the Special Commissioner for the Juries; the same post which he occupied so successfully in 1851. The leading "Decisions" to guide the Juries were published last September.

Arrangements have been concluded by her Majesty's Commissioners with Mr. Robert Hunt, F.R.S., who, it will be remembered, produced the Synopsis and Hand-Book of the Exhibition of 1851.

Mr. Robert Hunt has undertaken to produce a SYNOPSIS of the Contents of the Exhibition, which shall be ready for sale, in the building, on the 1st of May; and a HAND-BOOK, in Parts, which shall popularly describe the important productions of every class—whether British or Foreign—and which is to be published by the 1st of June.

By this arrangement it is hoped that the public will be furnished, on the one hand, with a cheap and easy guide to the immense collections in the "Synopsis;" and on the other, with a work of real educational value in the "Hand-Book" which will clearly describe every group which may possess any interest—and, indeed, interpret the value of each effort of thought—which nay be found in that industrial gathering,

Mr. Robert Hunt is bound to publish the "Synopsis" at the low price of 6d.; and the "Hand-book," in parts, which are not to exceed 6d. each, and which, when completed, shall sell bound for 5s.

NINTH ORDINARY MEETING.

WEDNESDAY, FEB. 12TH, 1862.

The Ninth Ordinary Meeting of the One Hundred and Eighth Session was held on Wednesday, the 12th inst., Dr. A. W. Williamson, F.R.S, Professor of Chemistry, University College, London, in the chair.

The following candidates were proposed for election as members of the Society:—

Ashworth, Edmund	Egerton-hall, near Bolton.
Barber, Charles	36, Fenchurch-street, E.C.
Bonnewell, Wm. Henry..	76, Smithfield, E.C.
Brearey, Plummer T. ...	20, Aldermanbury, E.C.
Brooks, Robert, M.P. ...	St. Peter's-chambers, Cornhill, E.C., and Woodcate-park, Epsom.
Browne, Edward	Oak-hill, Surbiton, S.W.
Buckley, Nathaniel	Ashton-under-line.
Bullock, W.	11, Paternoster-row, E.C.
Capper, C.	9, Mincing-lane, E.C.
Cocks, James...	25, Cornhill, E.C.
Foster, Wm. Watson ...	157, Fenchurch-street, E.C., and Felling's Works, Newcastle-on-Tyne.
Gunn, Alex. Hamilton...	79, Lombard-street, E.C., and 21, Water-street, Liverpool.
Horsey, Thomas	13, Billiter-square, E.C.
Hyde, John	7, Finsbury-place South, E.C.
Lloyd, Sampson S..........	Bank, Birmingham.
Mason, Hugh...............	Ashton under-line.
Moore, H. W.	3, Billiter-square, E.C.
Norton, Fletcher C.......	1, Albany-terrace, Regent's-park, N.W.
Payne, James Jabez	54, Aldermanbury, E.C.
Penny, George	5, Queen-street-place, Upper Thames-street, E.C.
Percy, John Thomas ...	26, Great Tower-street, E.C.
Rate, Lachlan M.	21, Upper Grosvenor-st., W.
Ridgway, Rev. Jas., M.A.	29, Oakley-square, N.W.
Roberts, Chas. William...	17, St. Paul's Churchyard, E.C.
Rosenthal, Ludwig	14, Mincing-lane, E.C.
Smith, William............	9, Mincing-lane, E.C.
Spence, James	77 and 78, St. Paul's Churchyard, E.C.
Styles, Thomas	148, Upper Thames-st., E.C.
Sugden, S.	12 and 16, Aldermanbury, E.C.
Trollope, Robt. Leonard.	15, Parliament-street, S.W.
Turner, Archibald.........	63, Aldermanbury, E.C., and Bow Bridge India Rubber Works, Leicester.
Veillard, Constant	29, Mark-lane, E.C., and 3. Foulis-ter., Brompton, S.W,

Whitmore, Charles S. ... 57, Rutland-gate, S.W.
Wier, A. M. .... 28, Threadneedle-street, E.C.
Wood, James............... 89, West Smithfield, E.C.

The following candidates were balloted for and duly elected members of the Society :—

Bridson, T. Ridgway..... Bridge-house, Bolton.
Challon, Charles .... 3, Berners-st., Oxford-st., W.
Clark, George .... Albion-chambers, Bristol.
Dunning, Joseph .... Langley, near Haydon-bridge, Northumberland.
Francis, David .... 24, Mile-end-road, E.
Foxwell, Thomas S....... Shepton Mallet.
Howes, John .... 45, Hamilton-ter., St. John's-wood, N.W.
Smith, Henry............... Bankfield, near Ulverston.
Thomson, John Robert... 19, Cadogan-place, Lowndes-square, S.W.
Wyon, Joseph Shepherd. 287, Regent-street, W., and 3, Langham-chambers, W.

The following Institution has been received into Union since the last announcement :—

Greville House (Pimlico) Working Men's Library and Reading-room.

The Paper read was—

ON THE ECONOMIC APPLICATIONS OF SEAWEED.

By Edward C. C. Stanford, F.C.S.

Sixty years ago it would have been difficult to persuade a botanist to include one of the Marine Algæ in his herbarium, so worthless and insignificant were they then esteemed; now they are numbered amongst the choicest dried collections from the vegetable kingdom. The seaside loving public, who seek health and relaxation in marine breezes have ample opportunities of seeing them in the freshness of life, and of watching their growth in the shallow pools that are left by the receding tide on our coasts; and we have all become familiar with their diversity of colour and delicate beauty. They have now so many admirers, and have become so popular, that it is unnecessary for me to speak in their praise; in fact, I intend in this paper to be a thorough utilitarian, and to view them only in their practical applications. But as the beauty of the algæ has been despised, so their utility appears to have been generally discredited. The Latin poets gave alga the prefix of "inutilis;" and Dr. Johnson has been often quoted, perhaps rather unfairly, as having included them in his "plants that are noxious and useless."

The first important application of seaweeds was made about the middle of the last century, it consisted in burning them for the ash, as a source of soda; but barilla from abroad entered our market, and the tall chimney of the alkali works rose up in competition against them, and seaweeds were again at a discount. Then the discovery of iodine was made, and the burning of seaweeds became a necessity; and even now we are mainly indebted to this humble source for the means we possess of borrowing the sun's light to paint his own image. We claim seaweed as the raw material which has enabled the photographers of our day to satisfy hundreds of thousands of our countrymen who have longed to preserve the likeness of the illustrious deceased, whose sudden call to another crown has plunged the whole nation in sorrow and mourning. Nevertheless, it must be admitted that the chemistry of seaweed has been but imperfectly studied, and by far the greater part of the rich wreck of marine vegetation annually deposited on our island shores remains unappropriated.

I shall first review the various applications of seaweed at present made, and then proceed to point out the best method of bringing our marine harvest to the national barn. I must premise here that under the collective term Seaweed I include all plants growing in the sea and thrown up on the shore, as I shall have to speak of one that is not a true alga. The present principal economic applications of seaweeds are—as food or medicine; as manure; and in the manufacture of kelp; under these three heads I shall consider them, noticing also a few other suggested uses, retrospective and prospective.

Seaweed as Food or Medicine.—The applications of the algæ in this way are very limited, particularly in this country. I shall merely briefly enumerate the principal species employed, and their uses, as an excellent paper on this part of my subject, by Mr. P. L. Simmonds, has already appeared in this Society's *Journal*, Vol. V., p. 362, and to this, and another by Dr. Macgowan, I refer those who are desirous of further information, as I am unable to add anything to them. The algæ possess nutritious and demulcent properties; they contain a peculiar gum, and sugar, starch, a little albumen, and a comparatively large proportion of nitrogen.

Laminaria digitata—Tangle, or sea-girdles; the fronds are occasionally eaten when young. The frond of this species no doubt constitutes the gôitre-leaf, chewed in the Himalayas, the whole plant abounding in iodine and potash, the important chemical remedies for gôitre. The stems of this plant make excellent handles for knives, files, &c., if the blade be inserted when the stem is fresh cut, and the weed then allowed to dry, it contracts, holding the blade with great firmness, and presenting a brown wrinkled appearance something like buckhorn. The handle, when varnished, is very durable, and this application is not followed to the extent its value would warrant.

Laminaria saccharina—Sweet tangle, called sea-tape in China, where it is eaten. This plant has been found by Dr. Stenhouse to be very rich in mannite—a peculiar unfermentable crystalline sugar, obtained usually from manna; and occurring also in the lilac and privet, plants belonging to the same natural order (*Oleaceæ*) as the manna ash—*Fraxinus rotundifolia*. This sugar contains $C_{12} H_{14} O_{12}$, and is formed also when ordinary cane sugar is submitted to lactic fermentation. It has no commercial application. This seaweed contains it in the proproportion of 12 to 15 per cent., and if there existed a demand for it, mannite could be advantageously prepared from this source. It may be generally seen on the dry frond as an efflorescence. Dr. Stenhouse has found that *Halidrys siliquosa* contains 5 to 6 per cent. *L. digitata*, the *Fuci*, *Aliaria esculenta*, and *Rhodomenia palmata*, and probably many others, also contain it.

Laminaria potatorum, under the name of bull kelp, is largely eaten in New Zealand and Van Dieman's Land, and is considered very fattening.

Fucus vesiculosus, bladder wrack, lady wrack, *quercus marina*, or black tang, is, according to Linnæus, used in Gothland, under the name of swine tang, boiled and mixed with flour, for feeding hogs. It is employed as winter food for cattle and sheep in the Western Hebrides. I have seen cattle in the Isle of Lewis eat it with evident relish, and they appear to thrive well on it. It has been much employed externally as a friction in glandular enlargements, and by Dr. Russell the juice has been given internally with advantage in the same complaint. Carbonized in a closed crucible, it constitutes the *Æthiops vegetabilis*, formerly used in scrofula.

Porphyra laciniata is pickled with salt, and sold in London as laver. It is stewed as a luxury in England and Scotland, and under the name of sloke in Ireland. It is also a good alterative medicine, and has been recommended by Professor Hervey (Phycolog. Britt.) as a valuable diet, in the absence of other vegetables, to our whaling crews sailing in high latitudes, where every rock at half-tide produces it. The London market is supplied from Devonshire.

P. vulgaris is eaten in China as a relish with rice, under the name of Tsz-Tsai (purple vegetable).

Ulva latissima, oyster green, or green laver, or sloke, is much inferior to the porphyra, but is used in the same manner.

Rhodomenia palmata, dulse, dillish, dulling or water-leaf, has an odour of violets, and a slightly acrid taste. The dried plant was formerly much chewed in Scotland and Ireland, but is now superseded by tobacco. Dulse and tangle were at one time commonly hawked in the streets of Edinburgh and Glasgow. It is eaten in Iceland and in the islands of the Archipelago; it is a favourite ingredient in ragouts, to which it imparts a red colour and thick consistence. It has sudorific properties, and is employed for these in the Isle of Skye. A fermented liquor is made of it in Kamschatka.

Laurencia pinnatifida, pepper dulse, has pungent properties, and is occasionally used as a condiment in Scotland. It is also chewed in Iceland.

Iridœa edulis, called dulse in the south-west of England, where it is eaten by the fishermen after pinching it between hot irons; thus cooked it is said to taste like roasted oysters.

Aliaria esculenta, bladder-locks, edible fucus, or hen-ware, is eaten in Ireland, under the name of murlins; it is also eaten in Scotland and Iceland.

Plocaria helminthocortos, Corsican moss, has been in use amongst the natives of Corsica as an anthelmintic for several centuries.

Durvillœa utilis, used as an article of food in Valparaiso, and by the poorer inhabitants on the west coast of South America. I am indebted to Mr. M. C. Cooke for a fine specimen of this species.

Eucheuma speciosum and *Gigartina speciosa*, are edible seaweeds, eaten in Australia.

Sargassum bacciferum is the celebrated gulf weed of the Atlantic; the stems are said to constitute the gôitre-sticks chewed in South America when that disease is prevalent; it is more probable, however, that the stems of the *Laminaria digitata* furnish these.

Chondrus crispus and *C. mamillosus*, Irish or Carrageen moss. These afford demulcent and nutritive jellies, and of all algæ are the most used in England for food and medicine; the market supply is obtained from Clare and the west coast of Ireland. The plant is sometimes employed in Ireland as a substitute for size. The *C. crispus* contains 79 per cent. of a peculiar gelatinous principle, called carrageenin; it differs from ordinary gum in not being precipitated by alcohol, from gelatine by affording no reaction with tincture of galls, and from starch jelly by giving no blue colour with tincture of iodine. It is precipitated by alcohol, acetate of lead, and infusion of galls, and converted into grape sugar by boiling with dilute sulphuric acid. It contains $C_{12}\,H_{10}\,O_{10}$ according to Schmidt, and $C_{24}\,H_{19}\,O_{19}$ according to Mulder. It is employed in pulmonary complaints, and in making bandoline.

Gelideum corneum. This plant is the algue de Java, which is made into an iced jelly, and sold in Ningpo, under the name of niu-mau (ox hair vegetable). It has lately been made the subject of an important discovery by M. Payen (*Rep. de Pharm.*, Jan., 1860). He has extracted from it 27 per cent. of a peculiar principle, which he terms gelose, having ten times the gelatinizing power of the best isinglass. With the same reactions as carrageenin, it differs from it in its wonderful gelatinizing power. I am indebted to the kindness of Mr. Daniel Hanbury for the very fine specimen of crude gelose, imported from Japan, which I am enabled to exhibit. I recently experimented on a large number of British algæ, to ascertain if these gelatinous principles were common to many species. I was somewhat surprised to find that very few contained them, and certainly none in anything like the proportion found in the *Chondrus* and *Gelideum*. Taking the *Laminaria saccharina* as a type of the membranous species of algæ, I found it to contain, besides mannite, 34 per cent. of a gum soluble in water, and much resembling dextrine. Boiled with a mixture of equal parts of nitric acid and water, this seaweed furnished 22 per cent. of oxalic acid, in fine crystals, probably from the decomposition of the gum. By boiling this seaweed with water, evaporating the solution, and treating the residue with spirit, the mannite is dissolved out, leaving the gum, which may be of commercial value, either as it is, or as a substitute for sugar, in making oxalic acid. The mannite may be crystallized from the spirituous solution.

The following algæ are also largely imported from the islands of the Indian Archipelago to China and Japan, for the manufacture of gelatinous compounds; they probably all contain carrageenin, or gelose, in large quantity. The most important is the *Plocaria candida;* this plant, called agar-agar by the Malays, and bulung at Java, is also imported into this country as commercial Ceylon moss. (The *Fucus spinosus* has been imported under the same name.) It has several synonymes, *Gracilaria lichenoides*, *Sphærococcus lichenoides*, *Gigartina lichenoides*, *&c.* The edible bird's-nests, esteemed as a delicacy in China, are probably constructed from this weed by a species of swallow—the *Hirundo esculenta*. It is said by Mr. Craufurd to form part of the cargo of every junk leaving the Archipelago, and the price on the spot is stated at from 5s. 8d. to 7s. 6d. per cwt. Though used largely as a food it is also employed as the best material for varnishing the Chinese lanterns.

Laurencia papillosa—tan-shwui—this, as well as the *Gelideum corneum*, is used in the preparation of tang-tsai, or Chinese moss.

Gracillaria crassa — Ki-tsai (hen-foot vegetable) — is cooked with soy or vinegar; and is also used as a bandoline for the hair by the Chinese ladies.

Nostoc edule is also eaten in China, and *Nostoc Arctium*, in the arctic regions.

There are many other algæ used exclusively as food by the Chinese, the botanic names of which are not known; but from the opening up of China and Japan to our countrymen, we may shortly expect much information on this subject. The Chinese are evidently the algæ-consuming nation, and there is no doubt that, in our own country, the algæ as food have been much neglected. Dr. Davy found the proportion of nitrogen in 100 parts of the dry plants to be as follows:—

Laminaria digitata......	1·583	Aliaria esculenta	2·424
Rhodomenia palmata...	1·656	Chondrus crispus	2·500
Gigartina mamillosa ...	2·198	Iridæa edulis	3·088
Fucus vesiculosus	2·397	Porphyra laciniata......	4·650

This a very large per centage, and equal to any of our other vegetable esculents. Researches directed especially to the algæ as food, would doubtless widely extend our present number of edible species. It may be remarked, however, that those already enumerated require much cooking and flavouring, in order to induce the national palate to acquire a taste for them; that John Bull, although so truly a man of the sea, certainly does not take kindly to an Algine diet, and there is no doubt, if it can be shown to his entire satisfaction, that a lucrative manufacture of chemical products can be conducted wherever there are seaweeds, hitherto esteemed useless, he would prefer vegetables grown in an ordinary garden, to dulse, laver, or any other such marine delicacy, particularly if the weeds can, by any means, be coined into money. It will be my aim, in this paper, to show that this is possible; but before leaving this part of my subject, I would call attention to special cases where the algæ may be very useful as food.

That scourge of our seaman, the scurvy, has been considered by many scientific men to be due to the insufficient supply of potash in the salt meat, the juice of which has diffused into the brine. The juices of limes and lemons are largely imported for its cure; if these act, as is supposed, by virtue of the potash they contain, a far better source may be found in the marine algæ. Let the most edible of these be selected for their use, and cooked as vegetables, they are well worth a trial; as they keep when dried, or may be often obtained fresh at sea, and if successful would save large sums to the nation, at present annually expended in the juices of limes and lemons; or, if the sailors cannot be induced to acquire a relish for marine vegetables, let the chloride of potassium, prepared from them, be used with common salt in due proportion for salting their provisions, the admixture could not be detected, and there can be no doubt that such a brine would be far superior, in its effects on the meat, to that commonly employed, where we take the juice containing the potash salts out of the meat, and substitute for it a saturated solution of chloride of sodium, with occasionally a small portion of nitre.

For cattle, let the use of seaweed for food be more extensively employed; they thrive on nitrogenous roots, containing phosphate of lime and salts of potash. The algæ are strictly comparable to these, as I shall show further on, with the addition that they contain common salt, which cannot be considered a disadvantage. We know that many species are eaten by cattle with great relish, the economy of the food is obvious, and its nutritive value need not be dwelt on.

Seaweed as Manure.—The value of seaweed as manure is most appreciated in the Channel Islands; the "varec" or "vraic," as the weed is there called, is considered so valuable that special laws are enforced for its regular collection and fair distribution amongst the agriculturists, many of whom use no other manure. "Point de vraic, point de haugard" ("no seaweed, no corn-yard"), has passed into a local proverb. The seaweeds are of two kinds—"vraic venant," and "vraic scié." The former is the drift weed cast up by stormy seas, on their sandy but rock bound shores; this is the most valuable, consisting chiefly of *Laminaria digitata* and *L. saccharina*, very rich in iodine and salts of potash; it is allowed to be raked up and collected all the year round, from sunrise to sunset, the time being prolonged during the winter to 8 p.m. This is the constant employment of the cottagers on the coast, both of Guernsey and Jersey, and the collection is at its height in stormy weather. The work is very laborious, the large wooden rakes used being often torn out of the hands of the "vraiqueurs" by the waves. The beautiful sandy bays which abound in these islands are the scenes of their toil. The weed is either thickly spread on the land, and ploughed in fresh with a deep plough, or dried on the beach, and burnt on the cottagers' hearths as fuel; certainly not on account of the cheerful appearance of the fire, or its pleasant odour, but because the charred ash thus produced, sells at 6d. per bushel for manure. The fire smoulders quietly; it is never extinguished, but constantly renewed, and the whitest of all smoke ascends night and day from the rude chimneys of these humble dwellings. The "vraic scié" is the "cut weed," cut off the rocks at low tide, consisting principally of *Fucus vesiculosus*, *F. serratus*, *F. nodosus*; the time of cutting it is fixed by law, at Guernsey, from July 17th to August 31st, and at Jersey twice a year, commencing March 10th and June 20th, and lasting about ten days each time. The summer cutting is made a regular holiday in both islands, and to the young "vraiqueurs" of both sexes it is an occasion of great festivity.

It is computed that about 30,000 loads of vraic of all kinds are annually obtained from the rocks and bays of Guernsey and the adjacent small island of Herm, valued at £3,000, or 2s. per load; this is a mere nominal price if the value of the potash and iodine alone be taken into consideration. The quantity of vraic collected at Jersey is, probably, quite equal to that obtained in Guernsey, but it seemed to me, during a recent visit, that the vraic used was generally not so rich, and that more is burnt and less ploughed in than at Guernsey. In one cottage I found the mother and all her family employed in drying and burning weed, composed entirely of the marine plant known as the grass wrack, *Zostera marina* (Nat. ord. Naiadaceæ) one of the poorest and most common of our seaweeds; the best front parlour was given up to its ignition—this was accompanied by an an insufferable odour, which the lady informed me was esteemed very healthy. This is a prevalent opinion amongst the peasants wherever seaweeds are burnt, and in this case I must confess that her statement was fully borne out by appearances, if I might judge by the rosy cheeks of her little assistants. She was getting the ash ready in a hurry to sow with corn on the following day, having, no doubt, the proverb before quoted weighing on her mind. The best seaweeds are stacked in Jersey; a dozen stacks of "vraic venant" thatched over, are common objects in a farm-yard, and small barns are given up to its storage when dry. The value set on vraic may be judged of by the fact that the inhabitants of Serk, having none on their island, import it in fishing boats from Herm, five miles distant; fifty Guernsey and Serk boats may be seen at once at Herm engaged in this traffic; and those who are acquainted with the precipitous nature of the rocks of Serk and its dangerous currents, will appreciate the value of vraic in that island. "Drift weed" is also largely used in Ireland, as the only manure for the potato crop; this is interesting, because the potato requires a considerable supply of potash. This alkali can hardly, however, be required in the Channel islands, as the granitic subsoil would, in disintegration, furnish it in abundance; it is probably the earthy phosphates that render the weed so fertilizing there; this is borne out by the fact that the lixiviated seaweed ash, from which the alkalies have been removed, meets with a ready sale in Guernsey, and is esteemed indeed richer, no doubt on account of the increased per centage of phosphates. The residual seaweed ash from the iodine factories in France, is highly valued as a manure, and constantly carried a distance of thirty miles from the factory. The agriculture in the western islands is also enriched by this manure, and some of the tangle is brought into Oban by fishermen in boats, and sold at 1s. per load. On the S.E. coast of Fife it is laid on the stubble at the rate of twenty cart-loads an acre, and ploughed in; the clover crop never fails, and this is a crop requiring much phosphate of magnesia, an important constituent of seaweed ash. In the Isle of Lewis twenty tons of seaweed are considered ample manure for a Scotch acre. The agricultural produce of the Isle of Thanet, in Kent, is said to have been tripled by the use of this manure, and the farms on the Lothian coasts let for twenty or thirty shillings more rent per acre, where the tenants have a right-of-way to the sea coast, where the weed is thrown ashore. In England, generally, however, seaweed is little valued by agriculturists as an actual manure, and appears to be regarded rather as an economical and useful covering to protect turnips and other roots from winter frosts. Farmers object to its bulk and expensive carriage, particularly now so many portable artificial manures are offered for sale and recommended so strongly by their manufacturers as possessing great fertilizing value in a small compass. There can be no question that many of these are worthless rubbish, and perfectly useless, except to line the pockets of the vendor; and the farmer would do well to turn his attention to the composition of seaweed ash, which really does, as I hope to prove, contain all the constituents of a good manure in a small bulk.

A process has been recommended by Dr. Stenhouse (*Philosophical Magazine*) for the manufacture of acetic acid from wet weeds by fermentation. His experiments were conducted with some of the Fuci; these were mixed with lime, and kept moist at a temperature of 90° Fahr.; he obtained by distillation with sulphuric acid an average of 1·5 per cent. of anhydrous acetic acid; it is contaminated with butyric acid. This might, however, be separated and turned to account in the manufacture of butyric ether or essence of pineapple. I have not heard of this suggestion being carried out, but it might be tried on those weeds intended for manure. In this case the best method would be to ferment them in pits with lime or chalk, at the ordinary temperature in the summer, leaving each portion in for two or three months, and supplying its place by a fresh load until the lime was saturated; the liquid would then be pumped out, evaporated to dryness, the residue sold as crude acetate of lime, and the weed carried to the manure heap. The whole process could be crudely and economically carried on by an agriculturist near the sea.

The ashes of several fuci have been found by M. Malafati to contain silver, as well as lead and copper in minute proportion. The silver in the ash of *Ficus serratus* is estimated at $\frac{1}{10000}$th of its weight, or about 3½ oz. to a ton. Other algæ probably contain this metal, as it has been found universally present in seawater; but, desirable as it may be to increase our stores of it, this would not be an economical source, and it is probable that the 2,000,000 tons, calculated by M. Tuld to be dissolved in sea water, might be better extracted by the copper sheathing of our ships, in which the copper is gradually replaced by the silver; the sheathing thus becomes after a time rich in silver. It has been found in the sheathing to the extent of 17 oz. in the ton.

The manufacture of paper is so important to a civicivilised nation, so many sources of the raw materials have been suggested, that we are not surprised to find seaweeds amongst the number. Two patents were obtained in 1855, the first dated June 20th, by Martenoli de Martinoi and others, of San Francisco, for the employment of seaweed in the manufacture of paper; and the second, dated November 29th, by Charles Maybury Archer, for the employment of seaweed in the manufacture of paper, and for the production of textile fabrics. Neither of these were proceeded with; the true algæ, in fact, having no fibres in their structure, would appear to be singularly inappropriate for the strength required in paper. Another patent was recently obtained by Ebenezer Hartnall, of Ryde, dated May 31st, 1861, for the application of the grass wrack, *Zostera marina*, to the manufacture of pulp for paper, to be used alone or in combination with other fibrous materials. This appears more practicable, as this plant is not one of the algæ, and it does contain fibre resembling the grasses. This patent, however, was not proceeded with.

Another patent was obtained in 1858, dated August 5th, by Donald M'Crummen, "for the application, use, and treatment of marine plants, heaths, or heather, and other vegetable productions, as well for the manufacture of paper as for the production of alkaline and other salts." According to his specification, the plants are crushed or bruised, and exposed to the action of boiling water or steam, until the soluble salts are removed; the insoluble residuum, after treatment with various agents of disintegration, is to be employed in the manufacture of paper, millboard, and papier maché. The solutions obtained to be evaporated to dryness to recover the salts. This is the only patent which has been proceeded with. I have received small specimens of the crude fibre, and black salt from Mr. M'Crummen, but in justice to him I am bound to state that they are sent to me as the first crude results, and he has not yet worked the process on a large scale.

THE MANUFACTURE OF KELP.—The manufacture of kelp, or the burning of seaweed to obtain its ash, was commenced about the middle of last century, and was first carried on for the value of the carbonate of soda contained in it, but when the high war duties were taken off foreign barilla and salt, kelp, for which the demand had been very great, deteriorated in value and was scarcely worth making. The carbonate of soda is never now extracted from this source; the yield was always small, and it is now obtained so cheaply from common salt. At the beginning of the present century, during the war, Highland kelp realised from £20 to £22 per ton. M'Cullock states that the kelp shores of the island of North Uist alone let for £7,000 per annum; that the Hebrides afforded 6,000 tons of kelp per annum, and the total produce of Scotland was 20,000 tons per annum, an amount which has never been manufactured since throughout Great Britain. When the duty was taken off barilla, Highland kelp fell to £3 per ton, and very little was produced. In 1812, iodine was discovered by M. Courtois, manufacturer of saltpetre, in Paris. The discovery was announced by M. Desormes, at the meeting of the French Institute on the 19th November, 1813. The attention of the discoverer was first arrested by the destruction of his copper pans employed in the decomposition of nitrate of lime by the alkaline lye of the kelp. Having constantly observed this phenomenon, he attempted its solution, and after much patient research and many failures, he succeeded in tracing the effect to the cause and in preparing iodine in a state of purity. The manufacture of saltpetre having failed, Courtois took to the preparation of iodine as a source of profit, but in consequence of its then very limited application, the enterprise was unsuccessful, and the project was abandoned, but it was taken up afterwards by M. Tissier, at Cherbourg; this gentleman founded a large factory which is still in active operation in that neighbourhood. Although, like many inventors, Courtois gained nothing by his discovery, a late distinguished English chemist turned it to good account, and made a large sum of money by buying up all the mother liquors of the Scotch kelp works, and extracting the new body. This element, iodine, has since been found widely diffused in nature, particularly in some aluminous slates, in varieties of coal and turf, in Chili nitre, in the silver and mercury ores of Mexico, and also recently by M. Chatin, though his conclusions are doubted by some chemists, in fresh-water plants, rain water, and dew. It exists also in many mineral waters, some of which owe their medicinal effects to its presence, and in cod liver oil. Some marine animals also contain it, oysters and sponges for instance. Kelp, however, is the only commercial source for its production, and the immense value of iodine, in photography and medicine particularly, has given an impulse to the manufacture of kelp, which renders it by far the most important of all the applications of seaweed.

As at present carried on, it has many disadvantages; these are well known to chemists, but, probably from the fact that it is conducted on desolate shores, at a considerable distance from centres of civilisation, it has not yet received that attention its importance demands; it was with the view of improving this promising application that I first commenced the researches I shall have the honour of laying before the Society this evening.

The manufacture is at present limited to a few parts of Great Britain, the western and northern islands of Scotland, the north-west coast of Ireland, and Guernsey.

In the Scotch islands the weeds are collected in the summer, dried in the sun, and burned in shallow rectangular pits; the fire requires a very high temperature, and the salts enter into igneous fusion; the fused mass is broken up by throwing water on it, and the kelp thus produced is a vitreous conglomerate, in the best specimens of which the carbonised stems of *Laminaria digitata* may be distinguished. It is of this plant—called bardarrig in the "drift weed"—that the most valuable kelp is made; if unadulterated it will yield the lixiviator from 10lbs. to 15lbs. of iodine per ton. The "cut-weed" is the *Laminaria saccharina*, called "Slaten-varra," but this is mixed with several Fuci, and generally the latter predominate; the kelp produced from it does not afford more than half the iodine yielded by the former.

The kelp in the N.W. of Ireland is made principally from the "drift weed" consisting of "sea rods," as the Laminaria is there called; it is burnt in small heaps, and at a lower temperature; the kelp produced is, consequently, more porous, and much richer than that from the western islands. Some of the drift weed, too, is stacked in the winter for burning in the summer; a portion of the Irish kelp is made from "cut weed," principally the Fuci.

Professor Graham first directed attention to the seaweed ash of Guernsey as the richest source of iodine; this results from the fact that the *Laminaria digitata* is used, and a very low heat is employed in the production of the ash. Mr. Arnold, of Guernsey, is the only lixiviator of kelp there, and he informed me that the local government had more than once tried to stop the lixiviation altogether, and owing to the peculiar laws of that island he is unable to carry it to any great extent. A large manufactory in one of the Channel Islands could produce immense quantities of iodine and potash, and the insoluble ash would still be retained as manure.

I am indebted to Mr. William Paterson, of Glasgow, who alone lixivates nearly four-fifths of the kelp of commerce, for the following statistics of the actual annual average amounts of kelp paid for, with the prices on the kelp shores. Those prices do not include freight and other charges incidental to the carriage of kelp to Glasgow. The average is taken on the last two years.

Western Islands.

1,800	tons cut weed kelp,	@ £2	£3,600
800	,, drift weed ,,	@ £4	3,200
400	,, ,, ,,	@ £6	2,400
3,000			£9,200

Orkney and Shetland Islands.

1,200	tons drift weed kelp,	@ £6	£7,200
150	,, cut weed ,,	@ £2 10s...	375
1,350			£7,575

Ireland.

2,500	tons of drift weed kelp,	@ £4 ...	£10,000
500	,, ,, ,,	@ £3 10s.	1,750
1,000	,, ,, ,,	@ £5 ...	5,000
500	,, ,, ,,	@ £6 ...	3,000
200	,, ,, ,,	@ £6 5s.	1,250
80	,, ,, ,,	@ £7 ...	560
1,300	,, cut weed ,,	@ £2 13s.	3,445
6,080			£25,005

Total Amount of Kelp, and Average Price, for the Years 1860-61.

Scotland...	4,350 tons,	@ about £3 17s.,	valued at	£16,775
Ireland ...	6,080 ,,	,, £4 2s.	,,	25,005
	10,430			£41,780

In round numbers, the average yield of British kelp may be taken at 10,000 tons, giving, at £4 per ton, an annual income of £40,000.

This quantity of kelp represents about 200,000 tons of wet weed, an amount which, large as it seems, is insignificant compared to the immense masses of seaweed annually deposited on the coasts of Great Britain and Ireland. The best drift weeds appear to be torn up from the Atlantic, as they are found chiefly on the western coasts in Guernsey and Jersey, the best are taken from the bays on the west coast, and the poorer sample of vraic I alluded to as having seen in a cottage at Jersey, was collected in St. Catherine's Bay, on the east coast. The "cut weed" is the same all round the islands. A great deal of drift weed, however, finds its way up the Channel, and is washed in and out of the numerous harbours and thrown on the flat coasts; this is particularly the case in Brading Haven, in the Isle of Wight, where it is carried in and out in large quantities. Many thousands of tons of seaweed of various kinds are deposited annually on the coasts of Sussex, but a small portion of which is utilized. Kelp is also still manufactured on the coast of Normandy in France. The weeds obtained are very similar to those of the Channel Islands.

MM. Tissier, ainé et fils, are the principal manufacturers of iodine and salts of potash in Bretagne. I have just received an important communication from these gentlemen, which furnishes me with valuable statistical information on the kelp manufacture in France. Their statements will astonish those who consider England to be in advance in this branch of industry; their position among the first and largest lixiviators of kelp, and their well-known name, are able guarantees of their ability to judge, and to speak practically, of this question. They estimate the total annual production of kelp (sonde brute) in France at 25,000,000 kilogrammes; this is about 24,000 tons, or more than double the yield of the kelp shores of Great Britain. MM. Tissier alone, in their Usine de Conquet, work annually 4,000,000 to 5,000,000 kilogrammes. They have favoured me with the following interesting table of the products annually extracted from this source by the seven principal factories in France:

USINES.	Iode et Iodure de Potassium.	Brome et Bromure de Potassium.	Chlorure de Sodium.	Chlorure de Potassium.	Sulphate de Potasse.	Nitrate de Potasse.
	kilos.	kilos.	kilos.	kilos.	kilos.	kilos.
Le Conquet..	20,000	1,500	800,000	500,000	200,000	200,000
Granville ...	20,000	800	800,000	...	...	1,000,000
Cherbourg ...	5,000	...	200,000	180,000	80,000	...
Montsarac ...	4,500	...	180,000	150,000	75,000	...
Pont-l'Abbé.	4,000	200	150,000	140,000	70,000	...
Portsall	4,000	...	150,000	140,000	65,000	...
Quatrevents..	2,500	...	100,000	90,000	50,000	...
	60,000	2,500	2,380,000	1,200,000	540,000	1,200,000

The lixiviation of British kelp is almost confined to Glasgow; a small portion only is worked in Ireland and Guernsey. There are six principal lixiviators—of these, Mr. W. Paterson is by far the largest; he works from 7,500 to 8,000 tons per annum. His enormous factory is well worthy a visit, and I am glad of an opportunity of acknowledging his attention and courtesy in showing me over it. The process usually followed is sufficiently simple; the kelp is lixiviated with water, and the solution evaporated; the sulphate of potash deposits first in small crystals, and then the chloride of sodium; these are separately collected, and the solution is then run off into iron coolers, where a crop of crystals of chloride of potassium is deposited in three or four days. This process is repeated with the mother liquor, and after the second crop of chloride of potassium has crystallised out, the mother liquor is very dark and contains sulphides; oil of vitriol is added to decompose these, and much sulphur is precipitated; this is one of the bye products of the factory. The liquor, after the addition of the oil of vitriol, is decanted from the deposited sulphur, and distilled with binoxide of manganese in leaden retorts; the iodine sublimes, and is received in earthen vessels.

This is an outline of the process generally adopted; it is simple and effective, and I can suggest no improvement; but its success is entirely dependant on the preparation of the kelp employed, and it is in the primary treatment of the seaweeds that reform is so much needed. As I shall have further to speak of the working up of seaweeds containing little iodine, I may just indicate that probably the best means of extracting it from the mother liquor of these, would be that recently discovered by MM. Stephanelli and Doveri. In their process, the liquor is evaporated to dryness, mixed with peroxide of manganese, and the iodine distilled off from earthen retorts; this saves the oil of vitriol, which is always used in Glasgow.

I propose first briefly to enumerate the disadvantages of the present method of making kelp; then to examine some suggestions for its improvement already proposed by others; and lastly, to publish my own researches on the subject, and their results.

The disadvantages of the present method are principally the following:—

1st. The high temperature developed in burning, by which much of the iodine is volatilised, and some of the potash; the loss of iodine is equal to the present yield.

2nd. The high temperatnre also enables the carbon to deoxidise the alkaline sulphates, reducing them to sulphites, hyposulphites, and sulphides. These become concentrated in the mother liquor, remaining after the extraction of the salts, and entailing a large expenditure of oil of vitriol for their reconversion into sulphates. Dr. Wallace (in a paper read before the British Association, at

Aberdeen, September 14, 1859) estimates the cost of extracting all the salts and the iodine from kelp, at from 25s. to 28s. per ton, of which from 11s. to 13s. are expended in oil of vitriol. The importance of this disadvantage is therefore obvious; the addition of the oil of vitriol to the mother liquor sets free large volumes of sulphuretted hydrogen, a noxious gas, very difficult to get rid of, resulting from the decomposition of these sulphur compounds. To such an extent is this deoxidation carried, that kelp prepared from the *Fuci*, which are rich in sulphates, gives off sulphuretted hydrogen on simple solution in water.

3rd. The crude manner in which the weed is burned in a rough clay pit, or in heaps on the beach, the kelp thus becoming mixed with the clay, sand, or stones, which are sometimes also employed as adulterations to the extent of 50 per cent.

4th. The general neglect of the winter supply, on account of the difficulty of drying the weeds at that season. This consists principally of the deep sea algæ, torn up by storms; it occurs in the greatest quantity, and is also much the richest in iodine and potash. Yet this is almost entirely lost. Even in the summer, during a wet season, large quantities of drift weed collected by the kelpers are rotted by the rain, and rendered useless for burning; and this, says Mr. Paterson, "was the fate of many thousands of tons during the last kelp season."

5th. The entire loss of the heat produced, and the products of combustion.

6th. The dense smoke and unpleasant odour evolved in burning, banishes the kelp burner to desolate shores, and, consequently, increases the distance of the lixiviating factory; the ash in its long transit suffers much by exposure to rain; and the residuum of lixiviation, a valuable manure in the country, is a bye product in a city. It may be urged, also, that the poor kelpers in their arduous work, receive but a small part of the real value of their labour.

These evils have been frequently urged, and are universally admitted; some reforms have even been proposed. Dr. Kemp has suggested a process, which consists in selecting the stems of those algæ which are the richest in iodine, and crushing them; they are then set by in a tank for a few days, and the most soluble salts, including the iodides, extracted by cold water acidified with hydrochloric acid. The solution is then treated with chloride of lime, and the iodine thus set free precipitated by amido-acetate of lead. The cakes of weed left after pressure are dried and used as fuel, the ashes being preserved *on account of the iodine they still retain*, as well as the other salts. This process has not been adopted probably because the manipulation, down to the burning of the fuel into ashes, is a complicated labour, superadded to the ordinary process, and with little advantage, for the ashes have still to be worked for iodine and potash. The crushing of the weeds, and the drying of the crushed cakes, present great practical difficulties, which those who have had any experience in compressing fresh vegetables will fully appreciate. Dr. Wallace's suggestion in the paper before referred to is more simple, he states that it is rather given to call attention to the subject than as a perfect process. He wishes to supersede the present fused kelp by a loose charred ash. He recommends the weed to be charred rather than burnt, and, as this ash, from its bulk, would be inconvenient for carriage, it should be lixiviated with a small quantity of water, and the solution roughly evaporated to dryness. He says, "By this treatment a very pure salt would be obtained, the iodine would be wholly preserved, while the cost of working would be more than counterbalanced by the saving of vitriol that would be effected by the absence of the sulphur compounds." This idea meets some of the difficulties of the question, but not all, the saving of iodine would to a great extent be effected, it would make just the difference which now exists between the best Highland kelp and that of the Channel Islands—the former a vitreous mass, with more than half the iodine volatilised, the result of igneous fusion—the latter a loose charred ash, the result of slow combustion, at a low temperature, and containing much more of the iodine. The difficulty, however, of completely charring on open slabs such a substance as seaweed, is considerable, and the salts resulting from its lixiviation would be coloured by any portion not thoroughly carbonized. The Guernsey kelp gives coloured solutions and dirty salts, which require recrystallisation before they can be brought into the market. It may be remarked of Dr. Wallace's suggestions, that they could not be carried out under cover, except by elaborate arrangements, on account of the offensive smoke occasioned by the products of combustion, which in his process are entirely dissipated.

My own researches were commenced by an estimation of the potash and iodine in seven of the commonest species of seaweeds; the results are shown in the following Tables:—Columns 1, 2, 3, 4, and 5, are the present kelp-bearing species. Columns 1 and 2, *Laminaria digitata* and *Laminaria saccharina* are the general constituents of "drift weed," or "vraic venant" of the Channel Islands. Columns 3, 4, and 5, the *Fucus vesiculosus*, *Fucus serratus*, and *Fucus nodosus* are generally the "cut-weed," or "vraic scié," of the Channel Islands. Columns 6 and 7, the *Zostera marina* and *Rhodomela pinnastroides*, have not yet been employed in the manufacture of kelp. They are exceedingly common all round the English coast, particularly the south; the latter has received no application, the former is largely used in stuffing mattresses.

The analyses are stated so as to show at a glance the relative value of each weed for commercial purposes. The water is that driven off at 212°. The organic matter includes the charcoal and everything dissipated in burning. In the analyses of the soluble portion of the ash, the potash and sulphuric acid are stated separately, and the alkaline chlorides indicate the total amount of chlorides of potassium and sodium, supposing the two alkalies existed entirely as chlorides. This was considered the best means of stating the results for comparison. A small proportion of carbonic acid contained in some of the salts was not estimated, because practically it is not separated. The kelp is the fused ash obtained in an open porcelain crucible. The best seaweed for working commercially would be that containing the most iodine and potash, and the least sulphuric acid.

The estimations of iodine were the results of a separate set of experiments, in which the weeds were carefully carbonised in a covered porcelain crucible, at a low red heat. The iodides were dissolved from the charcoal with water, and the iodine estimated as iodide of palladium. Thus treated, the weeds were found to yield much more iodine than when burnt, even at the same temperature, in an open vessel. When thoroughly burnt, the poorer weeds gave results which could scarcely be appreciated. *Laminaria digitata* gave 19 per cent., or less than half the yield from the charcoal; 19 per cent. corresponds to 12·77 lbs. per ton of kelp, and the iodine usually obtained from the best commercial kelp made from this weed seldom exceeds this amount. Mr. Paterson, who may be considered the highest authority on this question, states the present yield of iodine from good drift weed kelp to vary from 8 to 14 lbs., but the low quality of drift weed kelp produced in the islands of North and South Uist, and the county of Donegal, does not yield him more than from 4 to 6 lbs. per ton of 22½ cwt. He accounts for the bad quality of the kelp of Uist by the large admixture of sand from the shores of those islands. It is probably also much mixed with inferior seaweeds. The statement of the amount of iodine from the *Laminaria digitata* is the average of three estimations, and to show the amount that ought to be obtained from this species, I may state that this corresponds to 32 lbs. of iodine per ton of kelp (20 cwt.) Many of the analyses of seaweeds hitherto published have been performed on different kelps, and as these always contain the ash of several species, little dependence can be placed on them as an index of the relative composition of each species. The plants here experimented on were carefully selected. The amount of iodine will be seen to be exceedingly small in the *Fucus vesiculosus*, and kelp made from that seaweed alone would be valueless. It would yield only ·99 lb per ton, but practically it always contains the ashes of others sufficient to bring it up to about 4 lbs. per ton. Sarphati estimated the iodine in this species to be ·001 per cent.

I would call your attention to the large yield of potash from that very common weed, Col. 7. The soluble ash it yields is very variable in quantity, the fronds being always more or less covered with zoophytes, which largely increase the amount of ash without adding to the soluble portion. The results given are the mean of three analyses. The potash was in all cases estimated as the double chloride of platinum and potassum.

TABLE 1.—WET SEAWEEDS, CENTESIMAL.

SPECIES.	Laminaria digitata.	Laminaria saccharina.	Fucus vesiculosus.	Fucus serratus.	Fucus nodosus.	Zostera marina.	Rhodomela pinastroides.
Water	82·000	81·000	71·000	78·500	58·000	82·000	83·000
Organic matter	12·710	12·920	23·280	16·220	35·030	14·720	12·878
Soluble ash................	4·170	4·810	4·100	3·360	4·880	2·580	2·940
Insoluble ash	1·120	1·270	1·620	1·920	2·090	·700	1·182
Total	100·000	100,000	100·000	100 000	100·000	100·000	100·000
Yield of Kelp............	5·900	6·600	7·100	6·100	7·630	3·320	6·368

TABLE 2.—DRY SEAWEEDS, CENTESIMAL.

SPECIES.	Laminaria digitata.	Laminaria saccharina.	Fucus vesiculosus.	Fucus serratus.	Fucus nodosus.	Zostera marina.	Rhodomela pinastroides.
Organic matter..........................	70·112	67·646	80·358	75·079	83·412	81·796	65·748
Soluble ash	23·560	25·598	14·079	15·859	11·614	14·319	17·297
Insoluble ash	6·328	6·756	5·563	9·062	4·974	3·885	16·955
Total..	100·000	100·000	100·000	100·000	100·000	100·000	100·000
Yield of Kelp	33·335	35·112	24·381	28·782	18·159	18·444	37·460
COMPOSITION OF THE SOLUBLE ASH.							
Total amount of sulphuric acid.	2·135	1·627	4·165	4·620	2·927	1·498	2·619
Total amount of alkalies expressed as chlorides	21·526	23·886	11·400	14·396	10·733	13·209	15·910
Total amount of potash	6·893	8·958	2·043	4·408	2·546	3·940	6·075
Total amount of iodine	·4788	·1583	·00985	·0382	·0422	·0457	·0378

Many have been struck by the peculiar odour evolved in burning seaweed; this at the outset of these experiments arrested my attention, and led me to examine the products evolved in combustion. For this purpose various species of algæ were dried, and submitted to a low red heat in a cast-iron retort; and the products of distillation collected in a series of large Woulff's bottles; these products were in all cases the same, differing only in quantity:—

An inflammable gas;

Water, containing carbonate and acetate of ammonia, and a kind of naphtha;

A fluid tar, containing a volatile oil, some of which also floated on the water.

A light charcoal remained in the retort; this was lixiviated with water, and treated as ordinary kelp; the solutions obtained were colourless, and the salts perfectly white and pure. The mother liquor formed a striking contrast to those usually seen; it was nearly colourless, and contained mere traces of sulphur compounds; the amount of iodine yielded was unusually large.

The products of distillation were then examined. The gas burnt exceedingly well, giving a flame of little luminosity at first, but becoming very luminous towards the end of the distillation. A portion collected at first gave 41·66 per cent. of carbonic acid. Another portion, collected towards the end of the distillation, gave only 13·3 per cent. of carbonic acid, and contained olefiant gas. The gas given off in the distillation of wet weed is also inflammable, but the flame is occasionally extinguished by the vapour of water thus simultaneously generated; a portion of this gas gave 50.84 per cent. of carbonic acid.

The condensed liquid was very alkaline; it yielded ammonia in abundance on distillation with lime. The ammonia appears to exist in the liquid as bicarbonate—crystals of this salt were found in some of the gas tubes. The chloride of ammonium in the crude state prepared by neutralising this with hydrochloric acid has an odour of picoline, an alkaloid which is also found in the volatile oil. The naphtha distilled from this liquid burns with a slightly luminous flame. Rectified over lime, its specific gravity is ·826, this commences to boil at 155°; it is not a simple substance, but appears to be a mixture of acetone and methylic spirit; by repeated rectification I have succeeded in reducing the boiling point of the first portion below 140° Fah., but I have been unable to effect any definite separation of it, either by treatment with chloride of calcium or by repeated fractional distillation. It has been found impossible to separate methylic spirit from alcohol by this means, although the boiling points of the two liquids differ by about 30° Fahr. I was not surprised, therefore, that I failed to separate the two spirits believed to be the components of this naphtha, the boiling points of which differ only 10°. The presence of acetone considerably improves its value, as a solvent of sandarac and shellac. It has also, in the crude state, a peculiar odour, from the presence in small quantity of some etherial body, of which I have not yet obtained sufficient for examination.

The residuum in the still, after the distillation of the ammonia and naphtha, was found to be a solution of acetate of lime; distilled with hydrochloric acid, this furnished acetic acid, the last portions of which contained also butyric acid.

The tar was distilled with water, a volatile oil of very peculiar odour was thus obtained; the odour recalls that of burning seaweed. In the crude state it contains about 1·2 per cent. of the naphtha, and about 1·6 per cent. of a body analogous to kreosote. Diluted hydrochloric acid removes from it about 3·7 per cent. of a mixture of volatile alkaloids containing picoline, &c., and a red pitchy colouring matter is separated. It also contains pyrrol. After purification with oil of vitriol and caustic soda, the oil presents the appearance and properties of a mixture of pure hydrocarbons analogous to those from coal-tar naphtha. Its sp. gr. is ·841, and its boiling point rises from about 180° to above 400° Fahr. This oil must not be confounded with that obtained by Dr. Stenhouse, in distilling some species of Fucus with sulphuric acid, and named by him fucusol, and from which he prepared fucusamide and fucusine. The oil here treated of is a pure hydrocarbon, and has not been hitherto obtained from this source. It will be applicable to many of the uses for which coal-tar naphtha is so much in demand. The colouring matter separated by an acid from the oil is a product of decomposition. It is soluble in oil of vitriol, glacial acetic acid, alcohol, and methylic spirit. It is insoluble in water, either cold or boiling, and separated from all its solutions by its addition; it is also insoluble in chloroform, ether, benzole, bisulphide of carbon, oil of turpentine, the fixed oils, and dilute acids. It is unaffected by boiling hydrochloric acid. Nitric acid has no effect on it in the cold, but decomposes it when boiling, forming oxalic acid. Boiling oil of vitriol carbonizes it. It is decolourised by chlorine. The caustic alkalies partially decolourise, but do not dissolve it; the colour is restored by an acid. It is, however, chiefly remarkable in containing iodine, and it holds it in such close combination that boiling solution of potash does not remove it, and it is only when fused with hydrate of potash that it can be detected. It is thus converted into oxalate of potash and iodide of potassium; it was found to contain ·35 per cent. of iodine. I do not anticipate that it will be valuable as a dye, as it shows a tendency to fade; in a chemical point of view I look forward with interest to its thorough examination when I shall have obtained it in sufficient quantity; the greater the heat employed in distilling the weed, the more of this substance is produced. The tar, after the volatile oil had been removed, presented the appearance of Stockholm tar, which it might well replace; it was then distilled alone, and a fixed oil thus separated; this contains on an average 5·2 per cent. of a crude acid, analogous to kreosote. The oil, after this has been removed by potash, is purified with oil of vitriol, and it then resembles the paraffin oil of commerce. It will thus be seen that all these products are of considerable commercial value, and it remains now to show what are the quantities yielded—the same species were experimented on for this purpose—the weeds were compressed into cakes, and distilled in a small iron gas retort—the quantitative results are shown in the following tables.

The tar is that left after distilling in the presence of water. The volatile oil, having thus been removed, is stated separately, its weight being included in the aqueous portion. The paraffin oil is distilled from this tar; the paraffin in it was not estimated. The pitch left behind in the distillation was not weighed. The naphtha, volatile oil, and paraffin oil were in all cases measured, as (in the crude state) impurities tell more on the weight than on the measure.

The *Fucus nodosus*, No. 5, I could not obtain in sufficient quantity for distillation. The ammonia, tar, and oils were estimated in a tube experiment on the small scale. The measures of gas in all the tables are only approximative. A portion of the iodine is found among the products of distillation, and that is expressed in the tables as volatile iodine.

The products obtained from the residual charcoal are also shown in the tables, the alkalies, for convenience, being expressed as chlorides. The pure charcoal is the total amount of pure carbon yielded, and shows the value of each weed for heating purposes. The ash is pure, containing 20 per cent. of earthy phosphates; unadulterated kelp, as usually obtained, contains about double the quantity of ash there stated, the difference being unconsumed carbon; as, however, it contains the same amount of phosphates, it would be worth no more than the quantity here indicated.

TABLE 3.—Products obtained by the Destructive Distillation of Dry Seaweeds, Centesimal.

SPECIES.	Laminaria digitata.	Laminaria saccharina.	Fucus vesiculosus.	Fucus serratus.	Fucus nodosus.	Zostera marina.	Rhodomela pinastroides.
Charcoal, including ash	43·750	47·040	38·040	45·450	35·166	43·272	56·610
Tar	1·861	2·123	3·835	2·474	3·116	·805	1·078
Aqueous portion	24·509	27·151	31·988	24·978	24·434	25·341	29·931
Gas	29·880	23·686	26·137	27·098	37·284	30·582	12·381
Total........................	100·000	100·000	100·000	100·000	100 000	100·000	100·000
Products from the Water and Tar.							
Volatile oil	·707	·708	·989	·825	not estimated.	·312	·319
Paraffin oil	·698	·796	1·438	·928	1·168	·302	·404
Naphtha	·450	·427	·616	·315	not estimated.	·355	·480
Ammonia, or as	·609	·965	·736	·862	·929	·537	·611
Sulphate of ammonia	2·362	3·713	2·794	3·348	3·606	2·086	2·373
Acetic acid, or as	·194	·245	·620	·652	not estimated.	·181	·272
Acetate of lime	·259	·326	·816	·469		·241	·363
Colouring matter..................	·041	·093	·127	·077		·028	·029
Volatile iodine	·00724	·007039	not estimated.	·003128		not estimated.	not estimated.
Products from the Charcoal.							
Pure charcoal	13·862	14·695	18·398	20·529	18·578	25·068	22·358
Chloride of potassium	10·831	14·104	3·216	6·940	4·008	6·203	9·693
Chloride of sodium	10·695	9·782	8·184	7·456	6·725	7·006	6·217
Insoluble ash	6·328	6·756	5·563	9·062	4·974	3·885	16·955
Iodine	·4788	·1582	·00985	·0382	·0422	·0457	·0378

TABLE 4.—Products obtained by the Destructive Distillation of Dry Seaweeds, per Ton.

SPECIES.	Laminaria digitata.	Laminaria saccharina.	Fucus vesiculosus.	Fucus serratus.	Fucus nodosus.	Zostera marina.	Rhodomela pinastroides.
	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.
Charcoal, including ash	8 84	9 46	7 68	9 10	7 4	8 73	11 36
Tar	41·8 lbs.	47·5 lbs.	86 lbs.	55·4 lbs.	69·8 lbs.	18 lbs.	24·1 lbs.
Aqueous portion	55 galls.	61 galls.	72 galls.	56 galls.	54 galls.	57 galls.	67 galls.
Gas (approximative)	1,205 c. ft.	956 c. ft.	1,052 c. ft.	1,089 c. ft.	1,504 c. ft.	1,234 c. ft.	500 c. ft.
Products from the Water and Tar.							
Volatile oil	253·4 oz.	253·7 oz.	354·5 oz.	295·7 oz.	not estimated.	111·8 oz.	114·3 oz.
Paraffin oil	250·2 oz.	285·3 oz.	515·4 oz.	332·6 oz.	418·6 oz.	108·2 oz.	144·8 oz.
Naphtha	161·3 oz.	153 oz.	220·8 oz.	112·9 oz.	not estimated.	127·2 oz.	172 oz.
Sulphate of Ammonia	52·9 lbs.	83·2 lbs.	62·6 lbs.	75 lbs.	80·8 lbs.	46·7 lbs.	53·2 lbs.
Acetate of lime	5·8 lbs.	7·3 lbs.	18·3 lbs.	10·5 lbs.	not estimated.	5·4 lb.	8·3 lbs.
Colouring matter	·92 lb.	2 lbs.	2·8 lbs.	1·7 lbs.		·63 lbs.	·65 lb.
Volatile iodine	·1622 lb.	·1576 lb.	not estimated.	·07007 lb.		not estimated.	not estimated
Products from the Charcoal.							
	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.	Cwt. lbs.
Pure charcoal	2 86	2 105	3 76	4 12	3 80	5 7	4 52
Cloride of potassium	2 19	2 92	0 72	1 43	0 90	1 27	1 105
Chloride of sodium	2 15	1 107	1 71	1 55	1 38	1 44	1 27
Insoluble ash	1 30	1 39	1 13	1 91	0 111	0 87	3 43
Iodine	10·72	3·54	·221	·856	·645	1·024	·847

The following table is constructed to show the great loss of valuable products in the present manufacture of kelp. The quantity of iodine estimated as lost is approximative, as it is impossible exactly to calculate it, but I believe it to be here rather under than over-stated. The actual difference I found in the *Laminaria digitata* is shown in the first column. The amount of chloride of potassium stated as obtained is above the actual yield on the large scale, as part exists as sulphate, and much is driven off by the high temperature of the kelp fires.

TABLE 5.—Products now Obtained from a ton of Kelp, and those which would be Added by the New Process of Manufacture.

Now Obtained.

SPECIES.	Laminaria digitata.	Laminaria saccharina.	Fucus vesiculosus.	Fucus serratus.	Fucus nodosus.	Average.
	cwt. lbs.	cwt. lbs.	cwt. lbs.	cwt. lbs.	cwt. lbs.	cwt. lbs.
Chloride potassium	6 56	8 20	2 72	4 96	4 46	5 35
Chloride sodium	6 45	5 53	6 78	5 24	7 41	6 25
Insoluble ash	3 89	3 103	4 63	6 38	5 53	4 92
Iodine	0 12·77	...	...	...	...	0 5
Added by the New Process.						
Volatile oil	4¾ galls.	4½ galls.	9⅔ galls.	6½ galls.	not estimated.	6¼ galls.
Paraffin oil	4¾ galls.	5⅙ galls.	13⅕ galls.	7⅓ galls.	14⅓ galls.	9 galls.
Naphtha	3 galls.	2¾ galls.	5⅔ galls.	2½ galls.	not estimated.	3½ galls.
Sulphate of ammonia.	1 cwt. 46 lbs.	2 cwt. 17¼ lbs.	2 cwt. 32½ lbs.	2 cwt. 38½ lbs.	3 cwt. 108½ lbs.	2 cwt. 48 lbs.
Acetate of lime	17½ lbs.	21 lbs.	75 lbs.	36¾ lbs.	not estimated.	37 lbs.
Colouring matter	2¾ lbs.	5¾ lbs.	11½ lbs.	6 lbs.		6½ lbs.
Pure charcoal	8 cwt. 35½ lbs.	8 cwt. 59 lbs.	15 cwt. 10 lbs.	14 cwt. 41 lbs.	20 cwt. 49 lbs.	13 cwt. 39 lbs.
Gas (approx.)	3615 c. ft.	2771 c. ft.	4313 c. ft.	3811 c. ft.	8272 c. ft.	4456 c. ft.
Iodine	19·39 lbs.	...	...	...	...	5 lbs.

Table 6 shows the comparison of seaweed with peat in the products of destructive distillation. Peat is worked with profit in the Hebrides, and largely on the Continent, for these alone; the ash is valueles. The peat results in the table are taken from valuations by Messrs. Kane and Sullivan, for the Irish Peat Company. It will be seen that, in the products of distillation alone, the advantage is considerably on the side of the seaweed, while the lixiviation of the seaweed ash is already a lucrative manufacture, and its value will by this process of distillation be much increased.

A glance at table 6 will show the insignificant value of peat compared with seaweed.

These analyses conclusively prove that the present method of manufacturing kelp is an exceedingly wasteful one; for not only are the constituents of the ash largely dissipated, but these valuable products of distillation are all volatilised into the air; and taking, as a rough calculation 10,000 tons to be the annual yield of kelp, we have the following quantities annually disposed of in this manner:—

Volatile oil	62,500 galls.
Fixed oil	90,000 „
Naphtha	34,000 „
Ammonia:—	
(Calculated as sulphate)	1,216 tons.
Acetic Acid:—	
(Calculated as acetate of lime)	167 „
Pure carbon	6,674 „
Colouring matter	29 „
Gas	45,560,000 cubic ft.
Iodine	50,000 lbs.

TABLE 6.—PRODUCTS OBTAINED IN THE DESTRUCTIVE DISTILLATION OF DRY SEAWEEDS, COMPARED WITH THOSE AT PRESENT OBTAINED IN THE DESTRUCTIVE DISTILLATION OF PEAT.

	AVERAGE YIELD OF SEAWEED. Present Kelp-bearing Species, Nos. 1, 2, 3, 4, & 5.		AVERAGE YIELD OF PEAT. By Kane and Sullivan.	
	Per Ton.	Per 100 Tons.	Per Ton.	Per 100 Tons.
Volatile oil	289·3 oz.	181 galls.	320 oz.	200 galls.
Paraffin oil	360·4 oz.	225 galls.	157·7 oz.	98·6 galls.
Naphtha	162 oz.	102 galls.	66·3 oz.	42 galls.
Sulphate of ammonia	70·9 lbs.	3 tons 3 cwt. 34 lbs.	22·4 lbs.	1 ton.
Acetate of lime	10·5lbs.	9 cwt 42 lbs.	6·8 lbs.	6 cwt. 8 lbs.
Pure charcoal	3 cwt. 49½ lbs.	17 tons 4 cwt. 22lbs.	4 cwt. 103 lbs.	24 tons 11 cwt. 108 lbs.
Gas, approximative	1,161 c. feet.	116,100 c. ft.	1,475 c. feet.	147,500 c. ft.
Colouring matter	1·85 lbs.	1 cwt. 73 lbs.	...	...
Chloride of potassium	1 cwt. 63 lbs.	7 tons 16 cwt. 28 lbs.	...	...
Chloride of sodium	1 cwt. 79½ lbs.	8 tons 10 cwt. 110 lbs.	Valueless.	Valueless.
Insoluble ash	1 cwt. 34½ lbs.	6 tons 10 cwt. 90 lbs.	103 lbs.	4 tons 11 cwt. 108 lbs.
Iodine	3·26 lbs.	326 lbs.	...	...
Paraffin	Not estimated.	Not estimated.	3lbs.	300 lbs.

I leave commercial men to affix the values to these products (referred to in the preceding page as annually lost), and then weigh the amount against the £40,000 at present paid for the residuum of this waste. Can we wonder that the kelper works in rags? Can we be surprised that his operations are confined to desolate sea shores? Or is it astonishing that the kelp districts bring little revenue to their proprietors—that the tenants pay little or no rent, when they thus throw half their harvest away? It is difficult for those who have not visited these coasts to form an idea of the vast accumulations of seaweed thrown up in the winter, yet these, universally admitted to be the most valuable, are all lost. Is it possible that the utilitarian spirit of the age will permit this enormous waste to continue? Unless the lairds of the kelp districts take the subject up themselves it will still be so, for they cannot expect their poor tenants to erect works for this purpose, as the lion's share of the advantage must ultimately fall to their own lot. With the view of interesting them in the subject, I beg to call attention to the following proposed improvements:—

1. Seaweeds of all kinds are to be stored in sheds; they keep perfectly well under cover; they should be first collected in heaps, to drain off the superficial water, and then laid out in drying sheds; in summer, advantage may be taken of the sun's rays. Seaweeds, when laid out thin, are not so difficult to dry as is generally supposed, and when dry keep perfectly well under cover.

2. The seaweeds thus dried are then to be compressed into cakes, by hydraulic or other pressure; this is not essential, but the cakes occupy less room in stowage, and if the charcoal obtained is to be used for fuel, this treatment improves it.

3. The cakes, or the unpressed weed, are then to be distilled at a low red heat, in iron retorts; the tar and aqueous products to be collected in suitable condensers, and the gas in a gasometer. The gas may be employed for heating the stills used for rectifying the products, for heating the drying sheds, or even for lighting the factory; it might even be treated, according to Pettenkofer's method of superheating, and used as a means of lighting a district. The best kind of retort for the purpose will, I think, be cylindrical vessels of wrought iron, heated externally, and placed vertically, having the base and also the upper end conical; the former furnished with an air-tight iron damper plate, for withdrawing the charge when the carbonization is complete, and the latter provided with a moveable iron hopper for introducing the charge.

4. The charcoal is to be lixiviated and treated as ordinary kelp, and then thrown out in heaps to dry in the air. When raked from the retorts it should be allowed to fall into the lixiviating water, or into iron boxes, to protect it from the air; if the latter plan be adopted their heat may be rendered available for drying the weeds by wheeling them into the drying shed. The lixiviation will require larger tanks for its conduction than those at present employed, on account of the greater bulk of the charcoal; it has the advantage, however, of floating on water, and as the water in contact with it, when saturated, sinks to the bottom, it is quickly replaced by a fresh portion, and the solution is thus rapidly effected. The solution would be roughly evaporated to dryness, and the salt thus obtained sold to the lixiviator.

5. The washed and air-dried charcoal is to be used for heating the retorts and evaporating the solutions of the salts. Should, however, peat be very abundant in the neighbourhood this charcoal may be manufactured into manure, by treating it with the ammoniacal liquid; or be applied to some of the many uses for charcoal, and the peat employed as the fuel. The ash from the charcoal is a valuable manure; it usually contains over 20 per cent. of earthy phosphates. A few samples I have examined gave me the following results:—

	Laminaria digitata.		Laminaria saccharina.		Highland kelp.		Zostera marina.
Phosphates of lime and magnesia	24·16	...	18·50	...	22·83	...	15.90
Carbonates of lime and magnesia	16·10	...	20·11	...	18·38	...	16·37
Sand, &c.	56·76	...	57·78	...	56·56	...	65·36
Charcoal	2·98	...	3·61	...	2·23	...	2·37
	100·00	...	100·00	...	100·00	...	100·00

The phosphates of magnesia predominate, and these are partially soluble in water. The proportion of phosphate is about that in Peruvian guano, and if the crude ammoniacal salt obtained by distillation were added in the proportion of about 40 per cent., a manure would be obtained worth from £10 to £12 per ton, of which from 3 cwt. to 4 cwt. would be sufficient for an acre of land. The phosphate of magnesia it contains points to its special application to beet-root and clover. Mixed with about 5 per cent. of the chlorides of potassium and sodium, it would be equally beneficial to other root and cereal crops. Liebig divides crops, according to their wants, into three classes—potash plants, lime plants, and silica plants; such a manure contains the food for all or either of these.

6. The products of distillation I recommend to be treated as follows:—The tar is syphoned off, and distilled with an equal measure of water in an iron tar still; the light volatile oil passes over with the condensed water, on which it floats. This is decanted, and treated with dilute sulphuric acid, which removes picoline and other oily bases, and the red colouring matter is deposited. This substance is washed and dissolved in spirit, and the solution deposits it on evaporation. The light oil is then agitated with from 5 to 10 per cent. of oil of vitriol, washed with water and caustic soda, and finally re-distilled. The residual tar,

from which the light oil has been removed, is then pumped into another iron still, and a stronger heat applied. The paraffin oil is thus obtained, and purified by oil of vitriol, caustic soda, and re-distillation. The residual pitch may be employed for the manufacture of patent fuel, &c., or pumped while hot into brick ovens provided with an iron pipe to carry off the heavy vapours, and subjected to a red heat, by which a further portion of paraffin oil is obtained, and a good coke left in the still, commercially valuable to ironfounders on account of its freedom from sulphur. The liquid in the condensers, being separated from the tar, which sinks to the bottom, is mixed with excess of lime, and distilled in a capacious iron still provided with a suitable condenser. Ammonia and naphtha pass over, and are received into hydrochloric acid. The solution of acetate of lime remaining in the still is run out, evaporated to dryness, and the black, impure acetate thus obtained purified by charring, re-crystallisation, distillation, or conversion into acetate of soda. The ammoniacal distillate which has been neutralised by hydrochloric acid is re-distilled till the specific gravity of the distillate rises nearly to that of water. This is best distilled by the agency of steam. The first portion which comes over is the naphtha; this is collected separately, the weaker liquor subsequently distilled being returned to the still with the next charge. Redistillation over quick lime yields it in a state of purity. The solution of chloride of ammonium remaining in the still is run out, evaporated, crystallised, and the crystals sublimed according to the ordinary method of making sal ammoniac of commerce.

This, then, is the process, and it offers the following ad-advantages:—

1. Retention of the whole of the iodine.
2. Easy and rapid lixiviation, colourless solutions and pure salts.
3. Absence of sulphur compounds in the mother liquor, great saving of oil of vitriol, and no evolution of poisonous gases.
4. Factory to a great extent self-supporting, having its own means of heat and light, the fuel being extracted from the weed itself.
5. Manufacture continuous, affording employment to the kelpers all the year round, and at a higher rate of remuneration.
6. Extension of the manufacture, as this process allows a much larger margin for profit, and admits of the lucrative working of the commonest weeds, which will not, I anticipate, be allowed to rot on the shores of Great Britain when their commercial value becomes known.

These then are the principal features and advantages of this process; no doubt improvements may be developed in its minor details when it is worked on a large scale, but its general plan I believe to be the desideratum. If it be advisable that the ash should be sold for lixiviation to replace the kelp of commerce, it may be made more portable by raking the charcoal out into the air, when it gently consumes at a low temperature, and forms a loose ash containing very little carbon; the charcoal would thus be sacrificed, though an arrangement could easily be made by which it might be allowed to fall into an open chamber under the drying shed, and its heat of combustion thus made available. This might be adopted with poor weeds, such as the grass wrack, which are largely mixed with sand; but all those employed in the present manufacture of kelp should, I think, be treated as I have recommended. I have also tried distillation in a blast of air, but although the products obtained are nearly the same, the temperature is so liable to rise with the attendant evils alluded to, that I prefer the method I have indicated. Theories have been circulated amongst scientific men to show that the weeds on the Irish and Scotch western coasts only contain iodine in quantity, because they are nourished by the Gulf Stream, which impinges on these coasts, and is considered to be the carrier of iodine from the Gulf of Mexico. My experiments have led me to the conviction that iodine is pretty universally distributed in sea-water; that a large proportion of iodine is confined to a very few species of algæ, though nearly all contain traces; and that those species contain the same proportion wherever they may be found, but differing for each species and the way in which they are burnt. Thus, the weeds on which my experiments were conducted were all collected on the south coast of England, where they have been supposed to contain no iodine. Reference to my analysis will afford a conviction to the contrary. There are many seaweeds, however, which contain little iodine, but are well worth working for potash; thus grass wrack contains 15 per cent. in the ash, and *Rhodomela pinastroides* 16 per cent., and these have never been worked. The extraction of chloride of potassum from seaweed is not sufficiently thought of, as it is now one of our principal sources of saltpetre, on which so much depends in time of war; this is now made very largely, by the decomposition of nitrate of soda by chloride of potassium. Considering, then, the great value of seaweeds, as a source of potash, and as the only available source for that very valuable element iodine, it is not a question as to whether they should or should not be worked, but it is an absolute commercial necessity that the iodine and potash should be extracted from them; and the question is, what is the best method of doing it?

It is a remarkable fact that the principal commercial sources of ammonia are carbonised plants, in the shape of coal; and that these plants were mostly cryptogamic, and very near the algæ in the botanical scale; the present century has developed a source of unbounded national wealth in the former, and I believe that a great future is open to the latter. We reckon a country's riches not so much by its gold and silver as by the coal it is enabled to produce and consume; and although we do not now believe in the transmutation of metals, and we have desisted from our ancestor's fruitless searches for the philosopher's stone, the spirit of alchemy is still amongst us, and it presides over the extraction of valuable products from cheap and apparently useless materials. Seaweeds have been regarded in the latter class, and these researches will I hope be the means of directing attention to their intrinsic value.

My process has been patented in England and France, and I bring it before the Society of Arts because I am anxious to have it thoroughly discussed and criticised by the able men around me. If it passes that ordeal in a satisfactory manner I shall feel justified in urging the improvements on owners of kelp estates; and if I am not too sanguine in my expectations, a great reform will be introduced into, and a largely increased income will be derived from, the kelp-bearing districts of Scotland and Ireland, the social state of their inhabitants will be greatly ameliorated; and even in wealthy England, "Alga inutilis est," will be no longer a proverb.

DISCUSSION.

The CHAIRMAN said Mr. Stanford's paper contained so much matter that was interesting to the meeting, that he was sure many members present would take occasion to favour them with remarks on the subject. It was certainly wonderful that so small a portion of the valuable substances which these marine plants contained had as yet been turned to account.

Mr. T. N. R. MORSON could not help feeling that this Society was deeply indebted to Mr. Stanford for the very admirable paper he had brought before them—a paper which embodied a mass of facts and observations which they would search for in vain elsewhere. Mr. Stanford must have devoted an immense amount of time and attention to collect and bring before them all the matter embraced in the paper which they had had the pleasure of hearing. The subject of iodine was one which possessed a great degree of interest in this country, for it was a material of considerable commercial importance. It was, he believed, originally introduced at the enormously high price of £1 per ounce; it was afterwards sold by Dr. Ure at 7s. 6d. per ounce, since which it had declined to about 4d. per ounce, and the main advantage which had been derived to the manufacturers of kelp, had been from the potash salts which the seaweed contained. He believed no other person than the author had thought of employing distillation for the purpose of collecting other products, but he had no doubt, when this paper became known, attention would be called to the advantages of employing distillation, both in collecting those other products, and in increasing the amount of iodine obtained from these substances. He was sure they must all feel indebted to Mr. Stanford for this admirable paper, which he thought would have considerable effect upon the commerce of seaweed throughout the whole coast, so that the algæ would be much more largely employed than hitherto.

Mr. P. L. **Simmonds** said he had much pleasure in bearing corroborative testimony to the observations that had been made by Mr. Morson. Of the many valuable papers to which he had listened in that room, he did not remember one which he had followed with greater interest, or from which he had derived more practically useful information, than that with which they had been favoured by Mr. Stanford, a paper alike creditable to the industry and research of the author, and to the Society before which it had been read. The subject discussed was one in which he individually had taken much interest, and which had frequently been incidentally brought before the members. That the importance of the subject was not overrated was proved by the very liberal premium of £100 offered by Sir Walter Trevelyan—a premium which the erudition, experimental research, and eminently practical results of Mr. Stanford seemed to entitle him to. The mass of details and experimental results given could not be clearly appreciated from the mere abstract of the paper which had been read, but when the tabular statements, analyses, and practical information given came to be carefully examined and studied at leisure, the value of the paper, and the importance of the inquiry, as well as of the experimental researches carried out, would be better appreciated. Speaking for himself, he could but state that, having given some close investigation to the subject of the economic applications of seaweed for a work he was preparing for the press, on the utilization of waste substances and the undeveloped products, he thought he had, to some extent, mastered the details, but the paper of Mr. Stanford, in its exhaustive character, had quite taken the wind out of his sails, and left him little to add. When they considered, however, how little had yet been done with the vast mass of material forming the submarine vegetation of the ocean, while every other department of nature had been laid under contribution for the service of man, there was evidently wide scope for energy and investigation in applying this to useful purposes. France, it was shown, was already in advance of us in the kelp and iodine manufacture, and many other nations had given much more attention to the useful application of seaweed. We had occasionally, and locally, laid them under contribution for manure, or partial food use, as in the Sowl bread or laver, dulse, and tangle, and the so-called Irish moss; but they were applicable for many other purposes. As a stiffening substance they had been used in the place of starch and sago flour, and for size in the manufacture of paper. The French had lately used seaweed for wads for guns. But it was in the East, as Mr. Stanford had truly pointed out, that seaweeds were really an article of extensive commerce for food purposes and manufacturing uses. The so-called Japanese isinglass, or crude gelose, of which specimens were before them, showed the systematic mode of preparation, while the Chin-chow jelly, and the various species of Agar-Agar imported at all the ports, proved the extent of the trade. The statistics of this article, if they could be collected, would prove how important it was considered in the East. Between the 1st of November, 1858, and the 23rd May, 1859, nearly 11,000 cwt. of this seaweed was exported from the single port of Nagasati alone to China, where it was valued at about 8s. the cwt. Seaweed was collected over a wide extent of space for the Chinese market. It was also brought from Sooloo, and various islands of the Eastern Archipelago, by the tripang fishers. In Japan the *Laminaria saccharina* was in general use Presents which were universal among all classes, were invariably accompanied by a complimentary paper so called; slips of this Fucus were pasted to both ends of it. Some interesting specimens of this seaweed, of various species of *Gracilaria*, *Eucheuma*, and jellies made with it, were likely to be exhibited from Japan, from Ceylon, Western Australia, and other quarters at the forthcoming Exhibition. They were in more general use for several purposes than was ordinarily supposed. The gulf weed (*Sargassum*) was used by seamen as a pickle, and it was to be hoped that attention would be more prominently drawn to it as an anti-scorbutic. Without trespassing further on the time of the meeting, as he saw many gentlemen present very competent to speak on the subject, he begged again to thank Mr. Stanford for his very masterly paper, on a subject which had hitherto been so much overlooked, if not considered beneath notice, by scientific men.

Mr. W. E. **Newton** said one of the great advantages of this paper was, that it would draw the attention of manufacturers, chemists, and scientific men to a substance which seemed hitherto to have been left entirely in the hands of the roughest possible workmen. Everyone acquainted with the manufacture of kelp was aware that its manipulation was an operation of the rudest character as at present conducted, and therefore they owed a debt of gratitude to Mr. Stanford for not only directing their attention to the subject, but also for giving them some very valuable information upon it, and furnishing the details of the processes by which they could arrive at such important commercial results. With reference to the paper just read, he begged to take exception to Mr. Stanford's remarks on one point, and would endeavour to give a little information on one subject to which he had not referred. With regard to the employment of peat, Mr. Stanford had stated, that, whereas in the manufacture of different products from the distillation of seaweed, all the residuum obtained was useful—the ashes of peat were entirely valueless. To that statement he (Mr. Newton) must take exception, because those who had paid any attention to the manufacture of peat, knew that the ash or charcoal obtained after the gases and oily products had been extracted, was a most useful article for manure and for other purposes in the industrial arts and manufactures. He (Mr. Newton) brought this subject before the attention of the Society about a year and a half ago, and in the paper he then read they would find a great deal of useful information, which he had obtained from parties who had paid a great deal of attention to the subject. There was one very peculiar weed which had not been noticed by Mr. Stanford, but he was not surprised at the omission, because it was not generally known, and was very local, being found, he believed, only on the coast of the South of Africa and round the Cape of Good Hope. That was the buckhorn plant, so called from its great resemblance, when dried, to buck's-horn, and he had seen some very curious articles produced from this plant. It grew to very great length, and was tubular, and when treated in such a way as to render it soft and capable of being moulded, it could be used as the very best buck's-horn without the least difficulty. He believed it was one of those things which would, when more known, come into very general use. Its mode of application had only been lately discovered, and therefore it was not surprising that it should have escaped Mr. Stanford's attention.

Mr. Wm. **Hawes** remarked, that this was a paper in which the Society must feel considerable interest, because he believed he might say it originated from the prize that was offered by Sir Walter Trevelyan, which offer for two years was placed before the public by the Society at that gentleman's desire. A prize of 100 guineas was offered for the best essay upon Marine Algæ. The first year in which that prize was offered there were no papers sent in, and Sir Walter Trevelyan continued his offer for a second year. In the second year there were two papers sent in, one of which was by Mr. Stanford, and he might say that it created a very lively discussion amongst the gentlemen who were selected to determine the award of the prize. Whilst the discussion was going on, Mr. Stanford was pursuing his inquiries, and having succeeded in giving a more practical character to those inquiries, he withdrew the paper he had sent in, with the view of turning to account the information he had collected. He hoped to bring his name before the public as a scientific man and a chemist, and he withdrew his paper in order that he might use the information he had obtained in the prosecution of his researches, and convert them to practical and commercial uses. Soon after that Mr. Stanford took out the patent to which he had referred, and that evening they had heard for the first time that these marine plants, which they were accustomed to look at and admire, but to which they attached no practical value, were likely to become of great commercial importance, in increasing the means of providing food and substances useful in the arts. As a member of the Society, he felt greatly obliged to Mr. Stanford for the manner in which he had brought the subject before them. It was true that he had patented his process, but at the same time he invited the fullest discussion upon it, and told them in fact that at present he had merely patented it, and was waiting for public opinion to be expressed npon the soundness of his views before he took any further steps in bringing it before parties interested in the production of kelp, which was the only commercial use to which seaweed was at present applied. He was sure the members of the Society wished Mr. Stanford the success which a persistent course in a very dry investigation entitled him to, and that they would see in his case another instance of an individual being most thoroughly and completely rewarded for his devotion to a subject which had been neglected by all scientific men who had preceded him.

Dr. Mossom Meekins remarked that a relative of his had long used sea-plants as a manure, and his success in procuring very large crops was evidenced by several remarkably fine samples of his deposited in the South Kensington Museum. He believed the plan he adopted was to collect the seaweed when fresh, as it was driven on the shore, and make it into manure heaps, formed of alternate layers of weed and earth, allowing it to remain until entirely decomposed, and then spreading it like other manure. With respect to the getting and taking of seaweed, he observed, that anyone was entitled to take drift seaweed floating in the water, but if it once rested on the shore it belonged to the owner of the shore, meaning by the shore the space between ordinary high and low water mark. The shore, by common right, belonged to the crown for the benefit of the public, but sometimes it was vested in private individuals by grant or prescription. In every case he thought that the principle, which was applicable to the parings of roads (which the proprietor of the adjoining property might elect to take, but if he neglected to remove them within a certain time his right lapsed) might be applied to drift seaweed, which, if the proprietor neglected to appropriate within a certain time after high water, then it might be open to anyone to take it. This was obviously for the public good, as large quautities of these plants were constantly washed in, which, if not at once secured, were certain to be carried off by the next tide.

Dr. Redwood was anxious to bear his testimony to the great value of the communication made that evening. Having for many years had the pleasure of Mr. Stanford's acquaintance, he had had opportunities of observing the great zeal and praiseworthy perseverance with which he had pursued his investigations of this subject, the results of which had been laid before the meeting that evening. The importance to the manufacturing world resulting from this communication was of a varied character. Thus they had had indicated to them a method by which great improvements could be made in the mode of obtaining the products at present derived from seaweed, so that the quantities of iodine and potash salts could be greatly augmented, for, according to Mr. Stanford's process, they could get those salts in larger quantity, and in a higher state of purity than heretofore, being obtained at once from the lixiviation of the ashes. There were also other products which were at present entirely lost, but which might be turned in future to good account. It was doubtful whether these valuable products of distillation could now be made available; nevertheless Mr. Stanford had pointed out that by reducing the temperature at which the calcination of the seaweed was effected, they would derive an equivalent for an increased expenditure for the apparatus required for obtaining the augmented products. There was another point of considerable importance to which Mr. Stanford had directed their attention, ignorance with reference to which had hitherto led persons to neglect, to a great extent, giving any attention to the question of the manufacture of those products from seaweed. They had hitherto been given to understand, by persons who were supposed to be best acquainted with the subject, that the seaweed was not capable of yielding iodine in an available quantity, excepting when collected in certain localities. It was commonly stated that this was a peculiarity attaching to the kelp manufacture on the north-west coast of Ireland and in the west of Scotland, because in those situations the weed was watered by the Gulf stream, consequently, although the weed was found in great abundance on other coasts, it had been looked upon as worthless as a source of iodine, and no attempt had been made for years past to obtain iodine from the seaweed collected in such localities. Some years ago, it was pointed out by Mr. Graham that seaweed found upon the Channel Islands was capable of yielding iodine in sufficient quantity to make it worth the working; nevertheless, they had abundance of seaweed on other parts of the coast, which had been overlooked, and considered by practical men as useless for this purpose. Mr. Stanford's investigations had been directed to weeds collected in those localities, and it was a point of great importance that he had shown, that they were equally rich in iodine with those which had hitherto alone been practically worked for that purpose. Altogether, he thought the Society might congratulate itself upon having afforded Mr. Stanford an opportunity of bringing so important an investigation as this before the public, and he hoped it would be appreciated by manufacturers, as he was quite sure it would be by scientific men.

The Chairman said he was sure he should anticipate the unanimous feeling of the meeting when he proposed a vote of thanks to Mr. Stanford for his admirable paper. He could not refrain from expressing his high sense of the importance of some of the leading facts of this communication. New things were, of course, doubtful. If anybody brought forward a new substance, the first inquiry would be whether it was useful or not; but Mr. Stanford had shown that in the burning of seaweed a substance already known to be of great commercial value was wasted, viz., ammonia, which was one of the chief nutriments of plants; that which made wheat and bread was here entirely lost; and Mr. Stanford had shown that by the process he had described this ammonia could be collected and utilised. He had also shown that the substance for which seaweed was burnt —iodine—could be obtained by his process in about double the quantity as compared with the rough system hitherto adopted. Mr. Stanford's process would be most valuable, provided these products were shown not to cost more in their distillation than their present commercial value; but looking at the simplicity of the process, he did not anticipate that this was likely to be the case. It had been remarked by those who noticed the progress of invention that language generally had to undergo changes corresponding with the changes of the times. Now he, for one, did wish that the word "weed" should cease to be applied in the indiscriminate manner it was to marine plants. Hitherto "weed" meant a useless or noxious plant. Mr. Stanford had shown that a vast proportion of marine plants, so far from being "weeds," in the ordinary acceptation of the word, were extremely useful vegetables; and he hoped they would come before long to limit the word "weed" to those marine plants which were worthless, or which were not capable of being turned to account. He thought Mr. Stanford's paper would prove an important step in leading to this result. He begged to propose a vote of thanks to Mr. Stanford for his paper.

The vote of thanks having been passed,

Mr. Stanford said he could not thank the meeting sufficiently for the way in which his paper had been received, and for the patient attention which had been bestowed upon what he feared was to many rather a dry subject. He was particularly obliged to Mr. Simmonds for having supplied many deficiencies in his paper as to the economical application of edible algæ. He (Mr. Stanford) did not profess the botany of the subject; his information was almost entirely chemical. With reference to what had fallen from Mr. Newton, who had said that the charcoal from peat was a valuable residuum, he would observe that the results he had given were taken from the analyses which were expressly made for the Irish Peat Company; in their process the distillation was conducted in a blast of air by which the whole of the charcoal was destroyed, and nothing but ash left, which contained no phosphates, and scarcely any alkalies, and was consequently of no value as manure. He thought that result justified him in the statement, that whilst seaweed ashes were valuable, peat ash was valueless. With regard to what had fallen from the Chairman as to distillation, he believed it would be admitted that if iodine was obtained in larger quantity and the cost of sulphuric acid was saved, the additional expense of the more elaborate system of treatment would be covered, without reckoning the value of the products of distillation. For his own part he considered the whole cost of distillation would be repaid by the additional yield of iodine and chloride of potassium. He might add that he should rejoice to see the algæ rescued from the title of "weeds" and called "marine plants," and hoped this paper might be conducive in some measure to that end.

The Paper was illustrated by collections of foreign algæ, kindly lent by Mr. P. L. Simmonds and Mr. M. C. Cooke. A fine herbarium of British algæ, and a sample of crude gelose, as imported from Japan, were furnished by Mr. Daniel Hanbury. The chemistry of the subject was illustrated by a number of specimens of products obtained in the present manufacture of kelp; and by a complete series of the new substances added by Mr. Stanford's process. Specimens of gelose, carrageenin, oxalic acid, gum, and cellulose from the algæ, were also exhibited.

The Secretary announced that on Wednesday evening next, the 19th inst., a Paper by Mr. H. C. Salmon, F.G.S., F.C.S., "On the Relative Merits of the different Systems of Working Metallic Mines and Collieries," would be read.

The following letter has been received by the Secretary:—

"Sir,—I trust that Mr. Stanford's very able and interesting paper will have the effect of directing public attention to the properties and uses of those greatly-neglected members of the vegetable kingdom, the marine algæ. It is indeed remarkable that a raw material, presented to us in such vast quantities, should, up to the present date, have been allowed to remain without use or application, while the "utilisation of waste products" forms so prominent a feature in the arts and manufactures of the age. Great Britain alone, irrespective of Ireland and the Scottish Isles, possesses a sea-coast line of about seven thousand miles in length, from which I have reason to believe that seaweed could be collected to any amount, up to an average of 3,000 tons per mile per annum, or rather more.

"Of this vast and tolerably regular natural supply, what a minute proportion is now collected. Even in its most prosperous days, kelp was never manufactured to a greater extent than 28,000 tons per annum, as far as I can learn. The applications of algæ as food and medicine are, as Mr. Stanford truly observes, exceedingly limited, but I am of opinion that these might soon be very considerably extended if the inquiry were entered upon in a really systematic and practical manner.

"Several of the gelatinous varieties would doubtless become very palatable if boiled or macerated for a sufficient length of time in water or syrup (in the same way that the Chinese preserved ginger is prepared), or if converted into 'candy.' I have myself tasted some varieties of *Dictizota* and *Punctaria* thus prepared, which were by no means unpalatable.

"With the mucilaginous substance obtained from the *Gelideum corneum*, and other seaweeds, I have prepared paper for photographic purposes, giving pleasing 'tones' and very durable pictures.

"I have often regretted that the manna of commerce should remain so costly for the poorer classes, as if more reasonable in price it would be greatly in demand as a mild and simple purgative, especially adapted for children and many adults of delicate constitution. Now the retail price of this manna (which varies greatly in quality) is about 6d. to 10d. per ounce, according to the conscience of the druggist selling the same, while the same substance, or, more correctly, its active principle, mannite, might easily be sold for about 1½d. per ounce, if prepared in large quantity from seaweed. Some years back I extracted some pounds from the *Laminaria* (various species), and placed a portion in the hands of a provincial druggist, under the title of 'prepared manna.' It soon 'gave great satisfaction' to the customers, and the druggist offered to purchase the article at a higher rate than he paid for the foreign manna. I need hardly say that the transaction, being 'out of my line,' was 'declined with thanks.' In some specimens of *Laminaria* I have found as much as 17·5 per cent. of mannite.

"I am sure we are especially indebted to Mr. Stanford for his analytical tables of various seaweeds; these can require no corroboration, but for the sake of comparison I enclose a few of my own results in a similar direction.

"As regards the destructive distillation of seaweeds, a wide and useful field of research is open to us, as the kind and quality of the products obtained always vary with the temperature employed, a fact, I think, not mentioned by Mr. Stanford. Here I come to what strikes me to be the only weak point in the paper, the details of the distillatory process not being given with sufficient precision, any alteration in the amount of moisture present, or in the heat, altering the results accordingly. I have, on several occasions, obtained minute quantities of trimethylamine (and other similar 'ammonias') from various *Fuci*, by distillation in a current of steam, and should be glad to hear if others have met with the same results.

"Although the natural colours of many seaweeds are extremely beautiful—especially among the *Rhodosperms*—I do not think many attempts have been made to extract the colouring matters of these for dyeing purposes. In this branch of the subject I hope to have the honour of laying a few results before the Society. Several varieties of *Griffithsia* yield a brilliant crimson colour to pure water, which is precipitated again on the addition of certain soluble chlorides. This substance (which might be very appropriately called *Rubalgine*) appears to combine with alumina and other metallic oxides. Again, on many shores may be observed masses of a fine yellowish-brown alga, which, after a few hours' exposure to the sun's rays, change to a deep red hue; surely a chemist may take the hint here thrown out. The colour may generally be developed from these 'weeds' (*Plocamium*) artificially under the influence of an oxidizing agent, such as nitric acid or formiate of potassa.

"Even on this highly interesting subject, however, my observations must not be too lengthy, so I will conclude, for the present, with the remark that, in the ash of *Rhodomela subfusca* (of which I enclose specimens), I have determined as much as 19 per cent. of potash, a higher proportion, I think, than Mr. Stanford has met with.

"With best wishes for that gentleman's success in his valuable and extensive researches,

"I am, &c., "WENTWORTH L. SCOTT.

"Bayswater, London, W., Feb. 12th, 1862."

MEETINGS FOR THE ENSUING WEEK.

Mon......British Architects, 8.
Medical, 8½. Mr. Henry Thompson, F.R.C.S. Lettsomian Lectures.—2. "Lithotomy—Concluded. Lithotrity Instruments; their principles of construction; their adaptation to varied purposes."
Tues. ...Civil Engineers, 8. Continued discussion upon Mr. Samuda's paper, "On Iron-Plated Ships."
Statistical, 8. Dr. Levi, "On National Debts."
Pathological, 8.
Ethnological, 8. 1. Mr. John Crawfurd, "On the Civilization and Affiliation of the Races of Man from the evidence of their systems of Numeration." 2nd. Mr. W. Bollaert and Don Ramon de Silva Ferro, "On the Idol Human Head of the Jivaro Indians of Ecuador."
Royal Inst., 3. Mr. John Marshall, "On the Physiology of the Senses."
Wed. ...Society of Arts, 8. Mr. H. C. Salmon, F.G.S., F.C.S., "On the Relative Merits of the different Systems of Working Metallic Mines and Collieries."
London Inst., 7.
Thurs....Royal, 8½.
Antiquaries, 8½.
Linnæan, 8. 1. Mr. Masters, "On Axile Placentation." 2. Mr. Bentham, "On *Inocarpus edulis.*" 3. Dr. Harvey, "On *Algæ*," collected by Dr. Lyall on the north west coast of North America.
Chemical, 8.
Numismatic, 7.
Royal Soc. Club, 6.
Royal Inst., 3. Professor Tyndall, "On Heat."
Fri. ......Royal Inst., 8. Mr. James Fergusson, "On the Site of the Holy Sepulchre at Jerusalem."
Sat.......Royal Inst., 3. Rev. A. J. D'Orsey, "On the English Language."
Roy. Botanic, 3¾.

PATENT LAW AMENDMENT ACT.

APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, January* 31*st*, 1862.]

Dated 20*th January*, 1862.

140. W. S. Mappin, Birmingham—A new or improved lock.
142. T. Holt, Edward-street, Blackfriars-road—Imp. in folding iron chairs and chair bedsteads.
144. W. Boaler, Manchester—Certain imp. in the method of sizing paper yarns and woven fabrics, and in machinery or apparatus connected therewith. (A com.)
146. J. Bird, Blidworth, Nottinghamshire—An improved crank axle applicable to cranks of any description whatsoever wherein the wear is mainly on one side thereof.

Dated 21*st January*, 1862.

154. J. Bate, 18, Crescent, Birmingham—Imp. in machines for corking or stopping the mouths of bottles, jars, or any vessel requiring to be stopped up air-tight.
156. G. T. Bousfield, Loughborough-park, Brixton—Imp. in machinery for making nails and spikes. (A com.)
160. W. Burgess, Newgate-street—Imp. in reaping and mowing machines.

Dated 22*nd January*, 1862.

164. I. Roberts, Liverpool—Imp. in combined hydraulic motive power engines and meters.
168. T. Little and J. Little, Alston, Cumberland—Imp. in apparatus for cooling coffee berries.

[*From Gazette, February* 7*th*, 1862.]

Dated 30*th September*, 1861.

2438. E. Reoche, Rue d'Enghien, Paris—A new medicinal preparation applicable internally for rheumatism and other disorders.

Dated 22*nd November*, 1861.

2935. T. W. Davenport and S. Cole, Balsall Heath, Worcestershire—Improved compositions to be used in making buttons, beads, miniature and picture frames, and other articles susceptible of being moulded in a plastic material.

Dated 23*rd November*, 1861.

2492. M. A. F. Mennons, 39, Rue de l'Echiquier, Paris—An improved apparatus for the multiplication of motive power. (A com.)

Dated 4*th January*, 1862.

34. J. Howden, Glasgow—Imp. in steam engines and boilers.

Dated 9*th January*, 1862.

59. C. W Siemens, 3, Great George-street—Imp. in the means and apparatus employed for insulating and protecting telegraph conducting wires, and in apparatus for working the same. (Partly a com.)
68. B. Thompson, Birmingham—Imp. in ordnance and fire-arms, and in projectiles to be used therewith. (A com.)

Dated 10*th January*, 1862.

74. F. Moores, Warrington, Lancashire—An improved method of obtaining motive power by means of water wheels.

Dated 11*th January*, 1862.

86. W. Wilkinson, 20, Charlotte-street, Fitzroy-square—Imp. in ornamenting and decorating metals, glass, porcelain, parchment and other skins, and in the materials and ingredients employed therefor, also in protecting silver and gold on said materials, and on surfaces or plates of glass or metal, or plates of glass and metal combined, applicable to works of art, furniture, jewellery, and other articles of a useful and ornamental character.

Dated 14*th January*, 1862.

102. E. W. Hughes, 22, Parliament-street, Westminster—Imp. in malleable cylinders used in engineering and architectural structures.
110. J. Harris, Newton Abbot, Devonshire—An improved semaphore target marker.

Dated 15*th January*, 1862.

114. T. Timmins and T. Simmons, Birmingham—An improved bath, combining in itself the advantages of the hot air or Turkish bath with the vapour, slipper, hot and cold water shower bath.
116. H. D. P. Cunningham, Bury, near Gosport—Imp. in means or apparatus for protecting screw propellers from entanglement or being fouled by ropes or other bodies, also imps. in means or apparatus for closing up the screw aperture.

Dated 16*th January*, 1862.

117. J. Brooke, Leeds—Imp. in the form of lubricators.
121. W. Tristram, Bolton—Certain imp. in power looms for weaving

Dated 17*th January*, 1862.

125. J. M. Rowan, Glasgow—Imp. in the construction of steam hammers.
127. N. Thompson, 55, St. Paul's-road, Camden-town—Imp. in apparatus for stopping bottles.
129. R. Romaine, Devizes—Imp. in apparatus to be used in cultivating land by steam power, and in steam boilers used for agricultural and traction purposes.

Dated 18*th January*, 1862.

131. T. Emmott and J. Travis, Oldham, Lancashire—Imp. in the manufacture of velvets, velveteens, and other similar piled fabrics.
133. E. Davies, Warrington—Imp. in apparatus for gauging and cutting soap.
134. W. Helme, Caldbeck—A new or improved fire-lighter.
135. J. J. Stevens, Darlington Works, Southwark—Imp. in "point" indicators for railways.

Dated 20*th January*, 1862.

143. T. W. Jobling, Point-pleasant, Northumberland—Imp. in the adaptation of locomotive engines to traction or haulage in mines.
147. E. C. Nicholson, Locksfields, Surrey—Imp. in the preparation of colours suitable for dyeing and printing.
148. J. W. Agnew, Windsor-chambers, Great Saint Helens, City—A new or improved kind of last capable of being adjusted to various sizes and to various shapes of toes. (A com.)

Dated 21*st January*, 1862.

151. J. A. Knight, 4, Symond's-inn, Chancery-lane—Imp. in the permanent way of railways. (A com.)
152. J. F. Tourrier, 41, Manchester-street, Manchester-square—An improved method of, and apparatus for, warming adjoining houses by means of air chambers attached to grates in the party walls dividing such houses.

153. C. Binks, Gray's-inn—Imp. in generating steam, in superheating steam, and in apparatuses employed therein.

155. H. B. Barlow, Manchester—Imp. in machinery or apparatus for counting and indicating the number of revolutions of shafts or other articles, and for exerting power. (A com.)

157. J. H. Rawlins, Hope Paper Mills, near Wrexham—Imp. in machinery used in the manufacture of paper. (A com.)

158. A. J. Martin, High-street, Bow—Imp. in the treatment of fusel oil, and for various applications of the same to useful purposes.

159. R. A. Brooman, 166, Fleet-street—Imp. in street and road sweeping machines, parts of which are applicable to the separation of liquid from solid substances. (A com.)

161. M. Henry, 84, Fleet-street—Imp. in the mode of and apparatus for applying electricity to horology. (A com.)

Dated 22*nd January*, 1862.

163. L. Martin, Paris, No. 13, Rue Gaillon—Imp. in the treatment of mineral oils, and in the apparatus connected therewith.

165. F. W. Gerish, East-road, City-road—Imp. in printing presses.

166. E. Pace, Queen-street—Imp. in laths for Venetian blinds, in painting such laths, and in raising and lowering Venetian blinds.

167. A. J. Beer, Canterbury—Imp. in the valves of steam and other motive engines.

Dated 23*rd January*, 1862.

172. J. Wallace, Dumbarton, N.B.—Imp. in reaping machines.

174. W. H. Ropes, Crown-court, Old Broad-street—Imp. in machinery or apparatus for cleaning coffee, rice, or any seed or grain, having an outer hull and inner pellicle. (A com.)

176. G. Rogers, Staines, Middlesex—Improved mechanical arrangements for letting-off water or other liquids from butts, vessels, or cisterns.

177. J. C. Johnson, Nottingham—Imp. in the manufacture of twist lace in twist lace machines.

178. A. Ripley, Brook-street, Lambeth—Imp. in the construction of pistons.

179. H. Yates, Cecil-street, Strand—Imp. in machinery for bending, repairing, or renewing defective or damaged parts of iron rails.

180. J. G. Service, Glasgow—Imp. in machinery or apparatus for cutting and scoring pasteboard and other similar material.

Dated 24*th January*, 1862.

181. A. W. Williamson, University College, London—Imp. in tubulous boilers or steam generators.

182. J. Higgin, Manchester—Imp. in machinery for retarding and stopping railway carriages.

183. J. Cornforth, and B. Smith, Birmingham—New or improved machinery for boring or drilling gun-barrels and tubes and other articles having a cylindrical or prismatic figure, which said machinery may also be applied to other like purposes.

184. W. Clark, 53, Chancery-lane—Imp. in the manufacture of artificial flowers, leaves, and fruits. (A com.)

185. J. Longhurst, Ticehurst, Sussex—Imp. in chain and chain cables.

186. J. Rock, jun., Hastings—Imp. in common road carriages.

187. J. W. Girdlestone, Birkenhead—Imp. in projectiles for fire-arms.

189. C. G. Hall, Regent-street—Imp. in the manufacture of boots, shoes, and leggings.

190. A. Wallis and C. Haslam, Basingstoke—Imp. in thrashing machines.

191. J. Alison, Brightland, Reigate, Surrey—Imp. in apparatus for tilling land by steam power.

Dated 25*th January*, 1861.

192. W. Baker, Downham, Norfolk—Imp. in fire-arms, adapted to prevent their accidental discharge.

193. W. Johnston, Glasgow—Imp. in lamps.

195. J. C. F. Mougin, Paris—Imp. in barcelonnettes or cradles for children or for dolls.

197. D. Edleston and H. Gledhill, Halifax—Imp. in means and apparatus for finishing textile and other fabrics.

198. E. A. Curley, 4, Green-terrace, New River-head, Clerkenwell—Certain imp. in sewing machines.

199. J. Wright, Rochester, Kent—Imp. in constructing works below water.

200. F. J. L. Lefort, Bothey, Belgium—Improved mechanical arrangements constituting a secret and invisible safety lock applicable to iron safes and other depositories.

201. F. Roberts, Maiden Newton, and A. Roberts, Frome Vauchurch, Dorsetshire—Imp. in apparatus for ploughing or cultivating land.

203. A. Samuelson, 28, Cornhill—Imp. in hydraulic presses, and in the mode of working the same.

Dated 27*th January*, 1862.

206. S. A. Carpenter, Birmingham—An imp. or imps. in covering and combining strips or bands of steel for crinoline or crinoline skirts.

207. R. Martindale, Handsworth, Staffordshire—Imp. in globes and glasses to be used with hydro-carbon lamps.

208. C. W. Harrison, Lorimer-road, Walworth—Imp. in printing, stamping, embossing, perforating, and other like operations, and in the machinery or apparatus employed therein.

209. W. Orr, Greenock—Imp. in machinery or apparatus for the manufacture of sugar.

210. J. Smith, Spring-row, Keighley, Yorkshire—Imp. in the construction of covered rollers used in machinery for preparing, roving, spinning, twisting, and doubling fibrous materials.

212. T. J. Robotham, Burslem, and N. Hackney, Hanley, Staffordshire—Imp. in purifying slip, glaze, and other potters' materials.

Dated 28*th January*, 1862.

216. J. Hankins, Bristol—A new composition or wash to be applied to marine and other steam boilers to prevent incrustation.

217. J. Hunt, Birmingham—An imp. or imps. in the manufacture of gas and other chandeliers.

220. A. H. Church, 170, Great Portland-street—Imp. in the means of preserving stone, brick, slate, wood, cement, stucco, plaster, whitewash, and colour wash from the injurious action of atmospheric and other influences, also in the application of colours to the surfaces of stone, brick, slate, wood, cement, stucco, mortar, clay, plaster of Paris, plaster, whitewash, and colour wash, and in the retention of such colours thereon.

221. C. Culling, Downham Market, Norfolk—Imp. in fire-arms.

223. G. H. Morgan and E. Morgan, Grand Junction-terrace, Edgeware-road—Imp. in carriages.

224. G. Chapman, Rutland-street, Leicester—Imp. in rotating circular knitting frames.

225. G. J. N. de Ridder, 57, Rue Pigale, Paris—Imp. in railway carriages for the conveyance of travellers and goods.

Dated 29*th January*, 1862.

230. T. Clayton and W. Smith, Knowlwood, near Todmorden, Lancashire—An improved flyer.

232. L. A. Pulvé, 15, Passage des Petites Ecuries, Paris—Imp. in fireproof iron chests and strong boxes.

240. W. E. Newton, 66, Chancery-lane—Imp. in the boxes for the journals of railroad carriage and other axles. (A com.)

242. M. Collier, Failsworth, Lancashire—Imp. in looms for weaving.

Dated 30*th January*, 1862.

246. E. A. Rippingille, Staple Hill, near Bristol—Imp. in engines worked by steam or other fluid, and in pumps.

248. H. Robottom and R. Underwood, 31, Robert-street, Hoxton New Town—Imp. in watches and pocket chronometers.

250. W. Clark, 53, Chancery-lane—Imp. in mechanical wrenches. (A com.)

252. A. Lahousse, Brussels—Imp. in the manufacture of wheels for waggons, locomotive engines, and other vehicles used for railway purposes.

INVENTION WITH COMPLETE SPECIFICATION FILED.

298. W. E. Newton, 66, Chancery-lane—Imp. in the manufacture of iron and steel. (A com.)—4th February, 1862.

PATENTS SEALED.

[*From Gazette, February* 7*th*, 1862.]

February 5*th*.
1948. W. Galloway, J. Galloway, and J. W. Wilson.
February 7*th*.
1968. J. Eastwood and T. C. Eastwood.
1993. A. S. Stocker and A. R. Stocker.
1995. W. S. T. Clarke.
2004. A. Salomons.
2008. J. C. Horner.
2009. J. Jacob.
2011. S. Andrew and S. Hornby.
2012. J. G. Remy.
2024. E. Edwards.
2032. J. C. Martin.
2036. S. Desborough.
2692. C. Stevens.

[*From Gazette, February* 11*th*, 1862.]

February 11*th*.
2027. J. Billing.
2037. A. F. Menard.
2038. C. W. Kesselmeyer and T. Mellodew.
2042. T. Murcott and C. Hansom.
2043. J. Livesey.
2045. H. C. Hill.
2047. E. Sutton.
2079. J. Ellis.
2103. T. Richardson and R. Irvine.
2113. G. T. Bousfield.
2152. P. Jewell.
2153. A. V. Newton.
2179. J. M. Dunlop.
2197. G. Bischof, jun.
2220. T. Greenwood.
2284. W. E. Newton.
2354. C. Perman.
2556. G. Twigg.
2576. A. V. Newton.
3066. J. J. Russell & B. L. Brown.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

[*From Gazette, February* 7*th*, 1862.]

February 4*th*.
333. R. Tinkler.
380. B. Burrows.
February 5*th*.
383. J. Evans.

[*From Gazette, February* 11*th*, 1862.]

February 6*th*.
342. M. Curtis and J. Miller.
356. J. B. Redman.
February 7*th*.
343. J. Lee.
346. J. Smith.
406. W. E. Newton.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

[*From Gazette, February* 7*th*, 1862.]

February 5*th*.
441. G. M. Miller and J. Wakefield.

[*From Gazette, February* 11*th*, 1862.]

February 8*th*.
322. J. Ramsbottom.